SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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REPORT OF THE GENERAL SECRETARY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE FOR THE CHICAGO MEETING, CONVOCATION WEEK, 1907–8

THE fifty-eighth meeting of the American Association for the Advancement of Science was held from December 30, 1907, to January 3, 1908, inclusive, at the University of Chicago.

This was the second meeting in Chicago, and, including the one at New Orleans, the ninth which has been held so far west. The first Chicago meeting, the seventeenth of the association, was held in August, 1868. Several things about it seem of interest in this connection. The sessions were held in the Assembly Hall of the Y. M. C. A. Building and the Baptist Church, both located in what is now the downtown business section of the city. The meeting was under the auspices of the citizens rather than of any scientific or educational body.

During the war no meetings were held, but in 1866 an effort was made to revive the association, and a meeting was informally called at Buffalo. It was attended by 79 persons.

No better success as to numbers attended the regularly called meeting of the next year at Burlington, only 73 being present. The leaven was working, however, and the first Chicago meeting may be said to have begun a new period of prosperity.

This meeting was attended by 259 persons, the total membership being 428 at the time of assembling, showing a remarkably large ratio of attendance to membership. The enthusiasm which had been aroused was indicated by the fact that 261 persons took membership in the association at this meeting. The list of names is interesting. It includes many business men whose names have been and are prominent in connection with the enormous growth and development of Chicago's commercial interests.

It seems especially noteworthy that the list includes John Crerar, Orrington Lunt and G. C. Walker, whose names are associated, respectively, with the John Crerar Library in the city; the Orrington Lunt Library at Northwestern University, and the Walker Museum of the University of Chicago.

The majority of the 261 names belong to the city of Chicago, but the addresses are widely enough distributed to show that interest in science and in the association was awakened in all settled parts of the north. There were 151 papers presented on a wide range of topics. To one whose contact with the association is confined to later years, it seems odd to find a single sectional program containing papers on subjects belonging to astronomy, physics, chemistry, economics and engineering. Present at the meeting and presenting papers was G. W. Hough, then of Albany, N. Y., but for years professor of astronomy in the Northwestern University. So far as the writer could ascertain, he is the only one of those attending this first Chicago meeting who also attended the one just held, where he was present at the sessions of Section A.

The opening session of the meeting at the University of Chicago was held Monday, December 30, in Leon Mandel Hall, at 10 A.M. It was called to order by retiring President William H. Welch, who introduced President E. L. Nichols, who presided. Addresses of welcome were made on behalf of the university by Dean George E. Vincent, representing President Judson, and on behalf of the city by Mr. George E. Adams, vice-chairman of the local committee. President Nichols replied briefly on behalf of the association. An interesting feature of the addresses was the graceful reference of the speakers to the recent conferring of both the Copley medal and the Nobel prize on Professor A. A. Michelson, of the University of Chicago.

The address of retiring President Welch was delivered in the same hall on Monday evening and was intently followed by a large audience. After it the members of the association were received by Mrs. H. P. Judson and Dean Vincent.

The number of members officially registered for the meeting is 725. Members of affiliated societies not members of the association registered to the number of 185. It is certain that many members of the association failed to register, while comparatively few from the affiliated societies registered with the permanent secretary. No account was taken of visitors not members of any society. From data available at the close of the meeting, it is fair to assume that the number of persons attending was close to 2,000. The members of the association who registered are distributed as follows:

Illinois	221	North Dakota	3
Ohio	57	New Jersey	3
New York	56	North Carolina	3
Dist. of Columbia	47	Louisiana	3
Indiana	38	Texas	2
Wisconsin	36	Maine	2
Michigan	34	Mississippi	2
Minnesota	32	Kentucky	1
Missouri	31	Delaware	1

Iowa	25	Alabama	1
Pennsylvania	20	Virginia	1
Nebraska	16	Rhode Island	1
Massachusetts	15	Utah	1
Connecticut	11	California	1
Canada	11	Georgia	1
Kansas	10	South Carolina	1
Maryland	8	Oklahoma	1
Colorado	6	England	1
South Dakota	5	Hawaii	1
Tennessee	5	Japan	1
New Hampshire	4		

Taking the number present at 2,000 and applying the same geographical distribution would indicate that about 1,300 persons attended from within a radius of 500 miles against nearly 700 from a greater distance. As to distribution east and west, it appears that, leaving out Illinois and the two from outside the continent, the registered attendance from east of Chicago was 324, while from west of Chicago 178 persons registered.

During the meeting 309 new members were elected. One hundred and forty-two members were elected to fellowship. About one half of these are from membership in affiliated societies under the general rule adopted at the Philadelphia meeting.

The societies meeting in affiliation were the American Society of Naturalists, the American Mathematical Society (Chicago Branch), the American Physical Society, the American Chemical Society, the American Physiological Society, the American Society of Biological Chemists, the American Society of Zoologists (Central Branch), the Association of American Anatomists, the Association of American Geographers, the Society of American Bacteriologists, the Entomological Society of America, the Botanical Society of America, the American Psychological Association, the Western Philosophical Association, the American Anthropological Association, the American Folk Lore Society and the Bibliographical Society of America. In practically all cases one or more joint sessions of the society were held with the corresponding section of the association. In some cases the joint meeting included more than one affiliated society, and in at least one case two of the sections.

At one of these joint sessions occurred a symposium on "Cooperation in Biological Research"; at another a symposium on "Immunity." The one occurring in Mandel Hall, on Thursday, was devoted to an important and significant symposium on public health.

On Monday afternoon and Tuesday, sections A and B, with the Chicago section of the American Mathematical Society, listened to a series of addresses and discussions on the teaching of mathematics to students in engineering colleges. The large attendance to hear these addresses and discussions, together with the lively and often spicy character of the latter, fully attests the wide-spread and deep interest in this subject, one of great importance to engineering education. A committee was appointed to make an investigation of actual conditions bearing on the subject and to report its findings and recommendations to the Society for the Promotion of Engineering Education. This society took steps last summer to appoint a committee of somewhat wider scope, and it is presumed that the committee appointed at Chicago will work in conjunction with that of the professional society. A full account of the proceedings relating to the teaching of mathematics will appear in SCIENCE.

Among the discussions of general interest was the very vigorous one before Section I on "The Panic of 1907, and the Monetary System of the Nation." It is hoped that a full report of each of these general discussions will appear later in this journal.

The American Chemical Society, in affiliation with Section C, held a large and

enthusiastic meeting. Including the general papers and addresses, and the programs of the different sections of the society, over 150 papers were presented before this body. On Tuesday, Wednesday and Thursday mornings, sessions of general interest were held.

An important action of the council of the Chemical Society was the organization of the industrial chemists into a Division of Industrial Chemistry and Chemical Engineering, and the undertaking of the publication of a special journal of industrial and engineering chemistry.

The number of resolutions touching matters of general import which were adopted at the Chicago meeting was larger than usual. Of prime interest in this connection is the following letter:

The White House,
Washington Dec. 31, 1907.

My Dear Sir:—

I am sending you herewith copy of a letter which on November 11th I addressed to the Governors of each of the several states relative to a proper conservation of the natural resources of this country and inviting the Governors, with their experts, to meet in conference on this subject at the White House on May 13, 14 and 15 next.

I enclose also a copy of a letter recently received from the Chairman of the National Advisory Board on Fuels and Structural Materials, in which he suggests that in bringing this matter before the people of the country I invite the cooperation of the National Engineering Societies and other national organizations for research and development.

The suggestion is an excellent one; and I am led to believe that these organizations can render no more important service at this time than to develop among the people of this country a realization of the fact that these resources, upon which the future as well as the present welfare of the nation depends, are being exhausted rapidly, wastefully, and, in many cases, permanently.

I invite the cooperation of the American Association for the Advancement of Science in properly bringing this matter before the people; and it gives me added pleasure to invite you, as the President of the Association, to take part in this conference at the White House during May 13, 14 and 15 next.

Sincerely yours,
Theodore Roosevelt

The President of the American Association
for the Advancement of Science

Resolutions in accordance with this request were adopted as follows:

Realizing the rapid rate at which important natural resources of the country are being exhausted and the wasteful methods employed in the mining and utilization of other important mineral resources:

Resolved, That the American Association for the Advancement of Science joins President Roosevelt in calling the attention of the people of this country to the need of wisely conserving these resources for the future, as well as the present, needs of the nation; and in doing this the association asks the cooperation of its affiliated societies and other similar organizations throughout the country.

The association also urges upon the federal and state governments the importance of providing for such investigations and the enactment of such legislation as may prove necessary in preventing all unnecessary waste in the utilization of the nation's resources.

Resolved, That copies of this resolution be sent by the secretary of the association to the President of the United States, President of the Senate and to the Speaker of the House of Representatives in Washington; to the presidents and secretaries of the societies affiliated with the association, and of other similar organizations in the United States.

Resolved, That the president of the association appoint a committee of five on the conservation of resources, this committee to take such further action in carrying out this resolution as from time to time the conditions may demand.

Other resolutions of a public character which were adopted follow:

Resolved, That the American Association for the Advancement of Science reaffirms its resolution passed at the New York meeting, favoring the establishment by Congress of the Southern Appalachian and White Mountain Forest Reserves, and reappoints the same committee to present this matter to the Speaker of the House of Representatives and the President of the Senate in an endeavor to secure at this time at least a beginning of this important work.

Relative to the National Bureau of Education, the following resolution was presented from Section L and adopted:

WHEREAS, The National Bureau of Education has for forty years rendered a much-needed service to the educational interests of the country, and

WHEREAS, Owing to inadequate support its growth has for many years lagged far behind the general educational growth of the country at large and far behind the growth of the needs for such service as it can render, and

WHEREAS, It is undertaking to meet the new demands of educators by the publication of bulletins, by the reorganization of its library and bibliographical service, and by providing a national clearing house for all kinds of needed educational information; therefore, be it

Resolved, That the American Association for the Advancement of Science earnestly recommends to Congress the enactment of legislation in regard to the National Bureau of Education that will:

1. Foster and encourage its work and enable it to expand in such a manner as to render its services to American education increasingly effective and scientific.

2. Strengthen it by additions to its present staff of specialists.

3. Enable it to secure quarters adequate for its new work and in keeping with its dignity and usefulness.

4. Provide it with means to render more complete service as a distributing center for such information as is currently needed for the improvement of education in all its grades and enable it to include the collection and dissemination of information needed in the further development of professional and technological schools and the graduate departments of our universities.

5. Raise the salaries of the commissioner and staff of experts to such a point as will enable the bureau not only to secure men of the highest grade, but to retain them permanently in its service.

Relative to research in tropical medicine, the following resolution was adopted:

WHEREAS, There exists at the present time in Panama an extraordinary opportunity for research work in certain phases of tropical medicine, through the existence there of well-equipped hospitals and well-trained medical men under the supervision of an expert sanitarian, himself a member of the Isthmian Canal Commission, and

WHEREAS, The solution of problems connected with this subject is of the highest importance to the welfare of this and other countries, be it

Resolved, That it is the sense of the American Association for the Advancement of Science that Congress at its present session should appropriate funds for the purpose of establishing a research laboratory at the Isthmus which shall devote itself to the solution of existing problems in tropical disease.

Relative to public health there was adopted the following:

WHEREAS, The American Association for the Advancement of Science has appointed a Committee of One Hundred on National Health, and this committee is performing a work of great importance for the welfare of the nation, be it

Resolved, That all members of this association are urged to cooperate with the committee in its efforts to conserve and improve the health of the people and especially in its plans to increase the efficiency of the national government in dealing with the problems of public health.

The following resolution was adopted on the recommendation of Section F:

Realizing that the work in the Panama Canal is changing biological conditions in Panama and that the completion of the canal will enable the fresh-water faunæ of the two slopes to mingle freely and that many marine animals will succeed in passing the completed canal, the American Association for the Advancement of Science urges upon the President and Congress to make provision for a biological survey of the Panama Canal zone.

Since the conditions will be permanently changed as soon as the canal is completed and the work can not be satisfactorily done after the completion of the canal, there is great urgency that provisions for the work be made at once.

Resolved, That the permanent secretary be instructed to send copies of this resolution to the President, the Vice-President, the Speaker of the House and the Secretary of the Smithsonian Institution. (Signed) C. H. EIGENMANN,
C. C. NUTTING,
Committee

On recommendation of Section F the Association endorsed as its own the following resolution:

Resolved, That the American Society of Vertebrate Paleontologists will aid in any way practic-

able those measures legislative, international and local which will prevent the now imminent extermination of the great marine vertebrata, especially the cetaceans and manatees, seals, green and other turtles on the coasts of the United States or in the high seas.

The secretary of the committee on Seismology submitted the following resolutions which were adopted:

Whereas, The organized study of earthquakes lately undertaken in other countries is leading to a better understanding of their causes and to the discovery and adoption of means for mitigating their disastrous consequences, be it

Resolved, That, in the opinion of the American Association for the Advancement of Science, the government of the United States should at once make suitable provision for the installation and maintenance of seismographs in properly distributed stations, and,

Whereas, The United States Weather Bureau is the best equipped of the government bureaus for undertaking these studies, be it further

Resolved, That in the opinion of this association the necessary appropriations should be made to the Department of Agriculture for the United States Weather Bureau, and be it further

Resolved, That a copy of these resolutions be forwarded to the Committee on Agriculture of the United States House of Representatives.

At the suggestion of the Committee on Policy, as appears below, the following resolution was adopted:

Whereas, The late Major James Carroll, M.D., U.S.A., was the first to submit voluntarily to the bite of an infected *Stegomyia* and from the bite of this mosquito suffered a severe attack of yellow fever, the effects of which led to his ultimate death, and

Whereas, This was the first experimentally-produced case of yellow fever leading to the present knowledge of this disease, which has practically enabled its complete control, therefore, be it

Resolved, That the American Association for the Advancement of Science now in session in Chicago, Ill., recommends to the Senate and to the House of Representatives of the United States of America the passage of a bill securing to Mrs. Jennie Carroll, widow of the late Major James Carroll, of the Yellow Fever Commission of the United States Army, a special pension for the support of herself and her seven children.

The Darwin Memorial Committee, appointed at the New York meeting, reported as follows:

To the American Association for the Advancement of Science:

Charles Darwin was born February, 1809, and the "Origin of Species" appeared in November, 1859. In celebrating the semi-centennial of the latter we have the opportunity of celebrating the centennial of the former. Your committee consequently recommends:

1. This double celebration.

2. The date of the celebration to be during Convocation Week, 1908–9.

3. That the method of celebration be as follows:

(*a*) That a morning and afternoon of the meetings of the American Association for the Advancement of Science during Convocation Week, 1908–9, be devoted to a series of addresses on various aspects of the theory of evolution, and that these be given solely by persons actively engaged in research bearing on evolution.

(*b*) That a dinner be arranged on the evening of the same day, followed by addresses of a more general nature concerning Darwin and his work.

(*c*) That all addresses be published in a Darwin Anniversary volume, to appear during 1909, the anniversary year.

(*d*) That the committee have full power to arrange the program.

4. It is recommended that the committee be authorized to raise a fund to pay the expenses of Mr. Francis Darwin or other foreign speaker or speakers.

The Committee on the Investigation of the Cave Fauna of North America presented through the recorder, Professor C. H. Eigenmann, a report which will be printed later.

The Committee on Seismology through its secretary, Professor Wm. H. Hobbs, reported as follows:

Your committee organized with Professor H. F. Reid, of Johns Hopkins University, as chairman, and Professor W. H. Hobbs, of the University of Michigan, as secretary. The following sub-committees were named:

1, A committee to determine the best form or forms of seismograph for the seismological stations to be established; Messrs. Reid, Marvin and Bauer.

2. A committee of three members with power to add to its number to report as to what action is deemed desirable in reference to recommendations concerning earthquake-proof construction; Messrs. Lawson, McGee and Campbell.

3. A committee on stations. This committee is working in cooperation with the Weather Bureau, looking toward the establishment of seismographs in the stations of the Weather Bureau.

The Committee on Bibliography of Science submitted the following report:

The committee appointed a year ago has secured from Dr. Haviland Field full details in regard to the work of the Concilium Bibliographicum and from Dr. Cyrus Adler a series of documents bearing on the work of the International Catalogue of Scientific Literature. There is some duplication in the work of the two institutions, but we are of the opinion that the Concilium Bibliographicum should be supported. Apart from the Swiss state and municipal subventions, the only appropriation in 1906 for its work was that of the American Association for the Advancement of Science. It is somewhat doubtful whether the research fund of the association should be used for bibliographical purposes; but we are inclined to recommend the continuation of this grant if there are no more urgent demands on the fund.

The members of the committee live so far apart that meetings could not be arranged during the year. We are of the opinion that an active committee on the bibliography of science could render an important service to the association and for the advancement of science, but the members of the present committee fear that it will be impossible for them to undertake this work. We therefore recommend a new standing committee on the bibliography of science.

(Signed) R. S. WOODWARD
C. B. DAVENPORT
JAS. LEWIS HOWE
J. McK. CATTELL

The Committee on Policy through its chairman, R. S. Woodward, made the following recommendations of general interest, which were adopted:

1. That the committee on policy should in the future consist of the president, the retiring president, the treasurer, the permanent secretary and five other members.

2. That any member of the affiliated societies joining the association during the year 1908 should have his admission fee remitted and that a letter stating this fact should be addressed to all members of affiliated societies not already members of the association.

3. That the four great engineering societies (Civil, Mechanical, Electrical and Mining) and also the American Medical Society be invited to send representatives to the council of the association, and that the chairman of the committee on policy and the permanent secretary be appointed a committee to conduct the necessary correspondence.

4. That hereafter the annual volume be greatly reduced in size by omitting addresses and abstracts, and confining it simply to a list of members, constitution and the business of the meeting, and to devote the sum saved, not to exceed $850, to additional clerical help for the permanent secretary.

5. That the sum of $500, presented by an unknown client of Mr. John L. Bissell, of New York City, to the association be invested as a permanent fund, the income to be used for the general purposes of the association.

6. That the Committee of One Hundred on Public Health appointed by Section I of the association be made a committee of the association.

7. That the council adopt a resolution concerning a pension for the widow of the late James Caroll, the said resolution to be formulated by Messrs. Welch and Howard.

8. That the council approve the application of the American Federation of Teachers of the Mathematical and Natural Sciences for affiliation with the association.

9. That the council authorize a committee to consider the feasibility of a plan suggested by Mr. Newcomb concerning the advisability of the publication of reports of progress similar to those published by the British Association.

10. That the association look forward to the time when it shall employ a permanent secretary who may devote his full time to the work of the association and who shall receive an adequate salary.

11. That the committee on the relations of the association with the journal SCIENCE be discharged, and that a standing committee of three on organization and membership be appointed by the president.

One of the most earnestly discussed matters at the Chicago meeting was the relation of the association with the affiliated societies. The council reaffirmed its action

taken at the Philadelphia meeting permitting sectional committees to dispense with a sectional program whenever an affiliated society meets with the section, and to turn over all technical papers to a joint program of the society and the section. In discussing this question there appeared a wide divergence of opinion as to what action was *immediately* necessary. There was reported from some of the sections a strong sentiment in favor of making this action mandatory rather than permissive. The reaffirmation was accepted as a temporary expedient, and a resolution was adopted instructing the officers of sections to confer with the officers of the corresponding societies usually meeting in affiliation with reference to programs and policy, and to report to the permanent secretary for presentation to the council at the next meeting of the association.

The importance both to the association and to science of the proper solution of this problem of affiliation was clearly recognized. Conditions influencing it are different in the case of different sections, and some degree of patience and of toleration on the part of all concerned is called for during the effort to work it out. At Chicago the relations between the sections and the societies were of the most cordial nature, and this condition augurs well for the effort to arrive at a better working arrangement.

In accordance with various resolutions of the council the following committees were appointed by the president:

Additional members of the Committee on Policy, Messrs. Wm. H. Welch and N. L. Britton.

On preservation of the national resources, Messrs. T. C. Chamberlin, Irving Fisher, M. T. Bogert, W. F. M. Goss and Gifford Pinchot.

On organization and membership, Messrs. R. S. Woodward, L. O. Howard and J. McK. Cattell.

Section C appointed a committee to look into the question whether the report adopted by the section some years ago regarding the spelling of chemical terms represents the best present usage, or now has the endorsement of the section. The committee named consists of Messrs. W. A. Noyes, Chairman, L. P. Kinnicutt and C. L. Parsons.

In accordance with the recommendation of the Committee on Grants there was granted $100.00 to the Concilium Bibliographicum and $100.00 to the Committee on Cave Fauna. An appropriation of $50.00 from the general fund was made to pay the expenses of the committee on seismology.

The engineers and mathematicians dined together on Monday evening. The annual dinner of the American Society of Naturalists and that of the American Association of Geographers occurred on Tuesday evening. The former was followed by the address of the president of the society, Dr. J. P. McMurrich. On Wednesday evening there was held a smoker for the American Society of Naturalists, the Association of American Anatomists, the American Physiological Society, the American Society of Biological Chemistry, the American Society of Bacteriologists, the American Society of Zoologists and the Botanical Society of America. The annual banquet of the Sigma Xi Society was held on Thursday evening.

Social events ended with the meeting in a fitting climax at the dinner in honor of Professor Albert A. Michelson recent recipient of the Copley medal and the Nobel prize. Noteworthy among those present on this occasion was Professor Edward W. Morley, sometime a collaborator of the guest in honor, and who was present with Professor Michelson at the meeting of the Royal Society in December and received on that occasion the society's Davy medal.

The general committee fixed the place of the next regular meeting at Baltimore and the time Convocation Week 1908–9. It

also voted to hold a summer meeting, probably during the week beginning June 28, 1908, at Dartmouth College, Hanover, N. H.

Dr. T. C. Chamberlin, of the University of Chicago, was elected president of the association.

Dr. J. Paul Goode, of the same institution, was elected general secretary.

Dr. Dayton C. Miller, of Case School of Applied Science, was chosen secretary of the council.

The sectional officers stand as follows:

A—Mathematics and Astronomy.
Vice-president—C. J. Keyser, Columbia University.
Secretary—Professor G. A. Miller, University of Illinois.

B—Physics.
Vice-president—Carl E. Guthe, State University of Iowa.
Secretary—A. D. Cole, Vassar College.

C—Chemistry.
Vice-president—Louis Kahlenberg, University of Wisconsin.
Secretary—C. H. Herty, University of North Carolina.

D—Mechanical Science and Engineering.
Vice-president—Geo. F. Swain, Massachusetts Institute of Technology.
Secretary—G. W. Bissell, Michigan Agricultural College.

E—Geology and Geography.
Vice-president—Bailey Willis, U. S. Geological Survey.
Secretary—F. P. Gulliver, Norwich, Conn.

F—Zoology.
Vice-president—C. Judson Herrick, University of Chicago.
Secretary—Morris A. Bigelow, Columbia University.

G—Botany.
Vice-president—H. M. Richards, Columbia University.
Secretary—H. C. Cowles, University of Chicago.

H—Anthropology and Psychology.
Vice-president—R. S. Woodworth, Columbia University.
Secretary—Geo. H. Pepper, American Museum of Natural History.

I—Social and Economic Science.
Vice-president not chosen.
Secretary—J. Pease Norton, Yale University.

K—Physiology and Experimental Medicine.
Vice-president—Wm. H. Howell, Johns Hopkins University.
Secretary—William J. Gies, Columbia University.

L—Education.
Vice-president—G. Stanley Hall, Clark University.
Secretary—C. R. Mann, University of Chicago.

F. W. McNair,
General Secretary

THE INTERDEPENDENCE OF MEDICINE AND OTHER SCIENCES OF NATURE[1]

Sixty years ago, when the American Association for the Advancement of Science was founded, all of the main divisions of the sciences of nature existed as they do to-day, but no greater change has come over the face of science during these years than the many subdivisions which have arisen. Then the naturalist or the natural philosopher—how unfamiliar even the names are beginning to sound!—or the chemist could follow with critical judgment at least the work of all who were cultivating his own broad field of science, and a single scientific association, such as ours, could unite all of the workers in the natural and physical sciences into a relatively homogeneous and compact group, supply their needs for intercourse with each other and furnish a comprehending audience for presentation of the results of scientific investigation. To-day no man of science can pretend to follow all of the work even in his own department, and the investigator more often than not must seek an audience capable of critical understanding and discussion of his studies in a society of biological chemists, or of experimental zoologists, or of plant pathologists, or of dairy bacteriologists, or whatever may be the body

[1] Address of the retiring president of the American Association for the Advancement of Science, delivered at the meeting in Chicago, December 30, 1907.

which represents his own particular corner of science.

We may regret the loss of many charming features which have been erased from the landscape of science by all of this minute specialization, of which no one can foresee the end, but such a sentiment is much the same and as unavailing as that for the return of the days of the stage-coach. The great instruments of progress in modern life—steam and electricity in the industries, subdivision of labor and increasing specialization in science—are not altogether lovely, but they are the conditions of advancement in material prosperity and natural knowledge.

A necessary expression of the changed conditions of modern science has been the rapid formation of more and more highly specialized societies, which, it must be admitted, meet the personal needs of many individual workers more fully than a general association, representative of all the natural sciences, can possibly do. But the horizon of a man of science must indeed be narrowly circumscribed, if he can not look beyond what he conceives to be his personal needs and the little plot of ground which he cultivates to those necessities of science as a whole which an organization such as ours is designed to serve. The common interests of science grow with its expansion, and the more minute and specialized its subdivision, the greater the need of an association representative of these common interests—a central, national organization which shall keep to the front the essential unity of all the sciences of nature and of man, and the vital importance to the welfare of the community of the extension and application of scientific knowledge in all directions.

In order to serve most efficiently these common interests of science the central organization requires from time to time readjustment in details of plan and working to changed conditions resulting from the development of science and national growth, but its underlying purpose remains always the same. This purpose is so fundamentally important that its attainment in the fullest measure possible by this association should secure the personal service, the active interest and the zealous loyalty of all scientific workers and lovers of science in this country. The association becomes a living organism through the devotion of its members to its interests and, when fired by this breath of life, the machinery of organization, otherwise inert, is made a powerful instrument for the advancement of science. Gratifying as has been the growth of the association in recent years in membership and usefulness, no one will claim that it has taken full possession of its rightful heritage. The membership of the association should be doubled, yes trebled, to secure needful additions to its resources and influence. The time is near, if it has not already arrived, when the association urgently needs a central office and the services of an executive officer and secretary sufficiently recompensed to enable him to devote his main time, thought and energies to the perfection of the organization, to the extension of membership, to the voluminous correspondence, to the arrangements for the meetings and to other manifold interests of the association. Familiarity with the benefits which such an arrangement has secured for the medical profession through the remarkably effective reorganization within recent years of the American Medical Association leads me to place the first emphasis upon this direction of improvement for the organization of science.

In speaking, as I have done, of modern science as subdivided and specialized, in order to indicate some of the problems relating to the organization of this association, there is danger of giving a false im-

pression to those not fully informed of the actual conditions of science. In truth, the boundaries between the divisions and subdivisions of the sciences are being rapidly effaced by a deeper insight into the nature and phenomena of the material universe. Natural science has been compared to a continent separated into kingdoms, but a more appropriate comparison, it seems to me, is to the spectrum composed of different rays which merge imperceptibly into each other and combine into one white light with radiant energy to be discovered beyond the limits of the visible.

Who will undertake in these days of physical chemistry to separate the domain of the physicist from that of the chemist? The problems of the geologist have long been recognized as essentially physical and chemical in their nature. An ever larger part of the biological sciences, including the medical, is opening to exploration and conquest by physical and chemical methods. To mathematics belongs the primacy, for the exactness of a science is in direct ratio to the degree with which its subject-matter can be investigated by measurement and calculation, that is by mathematical methods. The ideal thus implied has been fully attained only by celestial mechanics, but it is approached by some other departments of physics. It is in accord with this ideal that Priestley admirably said that the object of science is "to comprehend things clearly and to comprise as much knowledge as possible in the smallest compass." The ultimate problems of reality and of knowledge belong to metaphysics which we may, following Descartes, bury deep in the soil as the root of the tree of science.

While this mutual dependence of all the sciences of nature, so significant of the operation everywhere of common principles and forms of energy and of an underlying uniformity in the order of nature, both animate and inanimate, is closest between the physical sciences in the restricted sense, it is strikingly illustrated in the history of the biological sciences, and it has seemed to me that the consideration of certain aspects of the interdependence of that department of biological science with which I am most familiar and the other sciences of nature would be an appropriate theme for an address by a representative of the science of medicine upon this occasion. It is to be understood that under the sciences of nature I include those of inanimate nature, the physical sciences, as well as those of organized beings, and indeed I shall dwell more particularly upon relationships between the medical sciences and physics and chemistry, for the points of contact between the various branches of biological science and medicine are self-evident and more familiar.

It need hardly be said that any systematic and full consideration of this broad theme far transcends the limits of an address and that in selecting particular aspects of the subject and certain illustrations I am quite aware that other points of view and other examples will come to the minds of my hearers as equally, if not more, worthy of presentation. Medicine has derived such inestimable benefits from the physical and natural sciences that I desire to lay some emphasis upon the services which it has rendered to them. For my present purpose it is not necessary to assign any limits to the operation of physical and chemical laws in living beings, for the most extreme vitalist must leave so large a part of the phenomena of living beings under the subjection of these laws that their application in medical and biological studies must always be of the highest importance.

An historical sketch, necessarily brief and inadequate, of some of the principal phases in the reciprocal relations between medicine and the physical sciences, up to

the time when the latter became fully independent at the close of the seventeenth century, will show with what propriety medicine has been called the "mother of the sciences."

Physical science has derived from the Greeks no such extensive records of sound observation and experience as those which medicine has inherited from the writings of Hippocrates and his followers. Physical theories embodied in the speculations of the nature-philosophers concerning the constitution and properties of matter furnished the starting point for the Hippocratic doctrine of the four humors and other generalizations, but these theories sat so lightly upon Hippocrates that his name is attached to that method of medical study which rejects dogma, authority and speculation and confines itself to the observation and record of clinical facts. As Gomperz in his admirable work on the "Greek Thinkers" has clearly pointed out the age of enlightenment in scientific thought was inaugurated by Hippocrates and his medical contemporaries.

The influence of physical theories upon medical thought in antiquity can be traced not only in the humoral doctrines of Hippocrates and of Galen, but also in rival schools, and especially in the so-called methodic school founded upon the atomistic philosophy of Democritus, which is so interesting in the history of scientific theories. As this school produced such admirable physicians as Asclepiades, Soranus and Aretæus it is to be regretted that their solidistic pathology was so completely displaced by the authority of Galen.

The large body of medical knowledge and doctrine which had grown up during the six centuries since Hippocrates was further developed and fixed by Galen at the end of the second century after Christ into a system not less complete in its field, nor less satisfying to the minds of men for nearly fifteen centuries, nor scarcely less remarkable as a product of the human mind than the physical and philosophical systems of Aristotle. Within their respective spheres the system of doctrine of each of these great men has exerted a similar dominating influence upon human thought and has met a similar fate through influences almost identical.

Although the contributions of the Greeks to mathematics were of the highest order, and the names of Aristarchus, Eratosthenes, Hipparchus and Ptolemy attest the great debt of astronomy to the school of Alexandria, and Archimedes had founded one branch of mechanics, and the works of Aristotle on "the history" and on "the parts of animals" entitle him to be called the "father of zoological science," I think that it is safe to say that the largest body of ordered natural knowledge in any single domain bequeathed by the ancients to posterity was represented by medicine. The botanists trace the beginnings of their science to the physicians, Theophrastus and Dioscorides, but botany was then, as it long remained, an integral part of pharmacy.

As medicine, practically in the shape in which it left the hands of Galen, continued for many centuries to be the shelter for most of the natural sciences, it is worth considering how worthy a home it furnished. For this purpose it is not necessary to enter into details of doctrine or even the state of existing knowledge. A few words concerning the general scope and spirit of medicine, as conceived and transmitted by the Greek physicians, must suffice.

Gomperz formulates the ideal of these physicians as regards their conception of the relation of medicine to the philosophy of nature in these words:

The human being is a part of the whole of nature, and can not be understood without it. What is wanted is a satisfactory general view of

the process of the universe. Possessing this, we shall find the key in our hand which will open the most secret recesses of the art of medicine.

Certainly such an enlightened conception of the relations of medicine, however unattainable it may be, is broad enough to provide welcome lodging under the roof of the healing art to any additions to the knowledge of nature. Although priestly and magic medicine and charlatanry existed then by the side of rational medicine, as they have always done, the Galenic system, which was a development of the Hippocratic, was in essence observational and inductive, mainly physical, as distinguished from vitalistic, and nearly devoid of superstition and the supernatural. Galen conceived medicine as a science and constituted anatomy and physiology its basis. He himself made valuable use in his physiological studies of the method of experiment, the singular and almost unaccountable lack of which is largely responsible for the fantastic, though often singularly prophetic, ideas and the sterility of the Greek natural philosophers as contributors to natural knowledge. Although later cultivators of the domain of medicine followed far behind these ideals of Greek medicine, there survived enough of their spirit to enable us to understand why the sciences of nature were for so long a time fostered within this domain, which furnished them a fitting and no unworthy abode until they were strong enough to build their own homes.

Although the Byzantine, Arabic and medieval periods afford a number of interesting illustrations of my theme, I shall not take time to consider them, for these periods were relatively unproductive for most of the sciences as well as for medicine. It may be noted, however, that the majority of the names which appear in the histories of the various natural sciences for these times figure also in the history of medicine.

The great awakening of western Europe, marked by the revival of learning and the reformation, stirred the long dormant spirit of inquiry and led to revolt against authority, a fresh outlook upon a wider world, the study of original sources, the questioning of nature at first hand and the search for new knowledge in all her kingdoms. The seat of learning was transplanted from the cloisters to the universities, which multiplied and flourished in the sixteenth and seventeenth centuries as never before.

For medicine and the sciences of nature the fire was kindled and for two centuries burnt brightest in the universities of northern Italy. Here the science of human anatomy was reformed and marvelously developed by Vesalius and an illustrious line of successors in the sixteenth century, and from this period onward anatomy never ceased to be taught by practical dissection, that is to say, by the method of the laboratory. It deserves to be emphasized that for over two hundred and fifty years human anatomy was the only subject taught in the universities by the laboratory method and that it thereby acquired a commanding position in the study of medicine. Bearing in mind the exceptional educational value thus imparted to the study of anatomy and that for a long time medicine was the only technical subject taught in the universities, we can not doubt that under conditions existing previous to the nineteenth century the study of medicine furnished the best available training for the pursuit of any branch of natural science. From his practical anatomical work the student could acquire the habit of close observation, manual dexterity and the sense for form in nature, and learn that real knowledge comes only from personal contact with the object of study. The term "comparative anatomy," even if it serves no other useful purpose, at least

points to the historical fact that human anatomy was the starting point and basis of comparison for the morphological study of the lower animals.

In the sixteenth century practically all of the valuable contributions to botany and to zoology were made by physicians, so that natural history scarcely existed apart from medicine. Of the medical contributors to botany it must suffice to mention the names of Brunfels, Fuchs, Dodoens, Gesner and above all Cesalpinus, who has been called "the founder of modern scientific botany," the most important name before John Ray in the history of systematic botany, and a distinguished figure likewise in medical history. Of names associated with the history of zoology in this century the most important are those of the physicians, Conrad Gesner, a marvel of encyclopædic learning, and Aldrovandi, who ranks with the founders of modern zoology and comparative anatomy; of lesser lights Edward Wotton may be singled out for mention as the pioneer English zoologist. He was doctor of medicine of Padua and of Oxford, president of the Royal College of Physicians, and physician to Henry VIII.

A name of the first rank in the history of science is that of the physician, Georg Agricola, who founded before the middle of the sixteenth century the science of mineralogy and developed it to a state where it remained for nearly two hundred years without important additions. I may here remark in passing that the first American chair of mineralogy was established in 1807 in the College of Physicians and Surgeons of New York and was occupied by Dr. Archibald Bruce, a name familiar to mineralogists, the founder of the first purely scientific journal in this country, the *American Journal of Mineralogy*, which was the immediate predecessor of Silliman's *American Journal of Science*.

The difficult step from Hippocrates and Galen to Euclid and Archimedes was surmounted by several physicians of the sixteenth century, as it has also been repeatedly in later times. The reader of Don Quixote will recall that as late as the seventeenth century the physician was also called "*algebrista*" in Spain, a survival of a Moorish designation—and the sixteenth-century physicians Geronimo Cardano, as extraordinary a figure in the history of medicine as in that of mathematics, and Robert Recorde, the author of the first treatise on algebra in the English language, exemplified the union of the healing art with the pursuit of mathematics as strikingly as did the Sedbergh surgeon, John Dawson, in the latter part of the eighteenth century, who had eight senior wranglers among his pupils and was one of the few British analysts of the period who could follow the work of the great contemporary, continental mathematicians. It may here be mentioned that of the celebrated Bernoulli family of mathematicians, two of the most distinguished, John and Daniel, were doctors of medicine, the latter being for a time professor of anatomy and botany at Basel.

The student of medical history, who takes up a history of physics, such as that of Rosenberger, will probably be surprised to find how many of the contributors to the latter subject in the sixteenth century were physicians and that among these are such old friends as Fernel and Fracastorius, whom he has identified so intimately with the annals of his profession. It is to be presumed that he already knew that the most famous of all, Copernicus, was a doctor of medicine of Padua and practised the medical art gratuitously among the poor in Frauenburg.

Far more important for the subsequent history of science than any relations between medicine and physics at this period

was the union between medicine and chemistry effected by Paracelsus and strengthened by van Helmont and Sylvius in the following century, a union so intimate that for nearly a century and a quarter chemistry existed only as a part of medicine until freed by Robert Boyle from bonds which had become galling to both partners. The story of this iatro-chemical period, as it is called, has been told by Ernst von Meyer in his fascinating "History of Chemistry" in a way not less interesting to the student of medicine than to that of chemistry, and should be there read by both.

In reply to the question what benefit accrued to both medicine and chemistry from their mutual interaction during this period von Meyer says:

> The answer is, a mutual enrichment, which did almost more for chemistry than for medicine; for the former was raised to a higher level through being transferred from the hands of laboratory workers, who were mostly uneducated, to those of men belonging to a learned profession and possessing a high degree of scientific culture. The iatrochemical age thus formed an important period of preparation for chemistry, a period during which the latter so extended her province that she was enabled in the middle of the seventeenth century to stand forth as a young science by the side of her elder sister, physics.

Paracelsus in carrying out his program that "the object of chemistry is not to make gold but to prepare medicines" made the pharmacist's shop a chemical laboratory and until the establishment of laboratories by Thomas Thomson and by Liebig in the first quarter of the nineteenth century this continued to be the only kind of laboratory available for practical training in chemistry. Through this portal entered into the domain of chemistry Lemery, Kunkel, Marggraf, Klaproth, Scheele, Proust, Henry, Dumas and many others. Liebig, who also began as an apothecary's pupil, has graphically described these conditions.

That strange, iconoclastic genius, Paracelsus, typifies, as no other name in science, the storm and stress, the strife, the intellectual restlessness and recklessness of the sixteenth century which prepared the way for the glorious light of science which illuminated the following century. With boundless enthusiasm minds, now fully liberated from the bondage of authority, entered upon new paths of philosophical thought and scientific discovery and achieved triumphs unequaled even in the nineteenth century. The great achievement was the full recognition and the fruitful application of the true method of science in all its completeness.

Although isolated and limited use had been made of the method of experiment in former times—I have already cited Galen and I might have added physicians of the Alexandrine school—the real birth of experimental science was toward the end of the sixteenth and the beginning of the seventeenth centuries. Medicine can hardly be said to have presided at this birth, but its influence was not absent. Galileo was a student of medicine, one of his teachers being the celebrated physician and botanist, Cesalpinus, when in 1583 he watched the great bronze lamp swinging before the high altar of the Cathedral of Pisa, and I question whether it would have occurred to anyone without some interest in medicine to determine the isochronism of the pendulum by counting the beats of the pulse. It seems improbable that without his medical training Galileo would have made the measurement of the pulse the first application of the new principle and have called the instrument the pulsilogon. Nevertheless we must bear in mind that natural philosophers of this period and throughout the seventeenth century were greatly interested in anatomy and physiology. Dr. Weir Mitchell in an address, as charming as it is erudite, has

called attention to interesting observations of Kepler on the pulse, which the great astronomer believed to have some relation to the heavenly motions, in this and certain other views exemplifying, as some modern physicists have done, the compatibility of a firm hold of positive scientific truth with an irresistible tendency to mysticism and occult science. Kepler was not, as has been stated, the first actually to count the pulse, for we read that as long ago as the Alexandrine period Herophilus timed the pulse with a water-clock.

But if Galileo was only half a doctor of physic, as Dr. Mitchell calls him, his elder contemporary, William Gilbert, second in importance only to Galileo among the creators of experimental science, the founder of the science of magnetism and a significant name in the history of electricity, was fully identified with the profession, being the most distinguished English physician as well as man of science of his day, physician to both Queen Elizabeth and James I., and president of the Royal College of Physicians.

Galileo's younger contemporary, William Harvey, the discoverer of the circulation of the blood, occupies in the history of experimental science an independent position, quite unlike that of the other experimental physiologists of the century. These other physicians, as Sanctorius, Borelli, Lower, Mayow, consciously took possession of the method of experiment as a powerful and newly discovered instrument of research and were swayed in all their physiological work by the discoveries of the physicists. Not so Harvey, who was influenced but little by contemporary physical science and is linked on, not to Galileo or to Gilbert, as exemplars of experimentation, but in a very direct way to the experimental physiologist, Galen, and to Aristotle, as well as to the Italian anatomists of the preceding century. Harvey's genuinely scientific mind was in greater sympathy with Aristotle than with the essentially unscientific Lord Bacon, who was his patient and of whom he said, "He writes philosophy like a Lord Chancellor."

There is no more striking characteristic of seventeenth-century science than the wide range of inquiry covered by individual investigators. The natural sciences were no longer apprenticed to medicine, after Boyle had liberated chemistry, but the problems of anatomy, of physiology and even of practical medicine were not separated from those of the natural philosopher and of the naturalist. With unparalleled versatility every one seemed to roam at will over the whole domain of knowledge and thought. How they leaped and tumbled in the virgin fields and hied "to-morrow to fresh woods and pastures new"!

Descartes was an anatomist and physiologist as well as philosopher, mathematician and physicist, and John Locke, the other great liberator of thought in this century, was educated in medicine, practised it and, like Boyle, accompanied Sydenham on his rounds. Kepler studied the pulse, contributed to physiological optics and calculated the orbits of the planets. Borelli was an important mathematician, physicist and astronomer, as well as one of the greatest physiologists and physicians of the century. Bartholinus was also professor of mathematics as well as of medicine, and discovered the double refraction of Iceland spar. His even more remarkable pupil, Steno, left a name memorable in geology and paleontology as well as in anatomy and physiology, and died a bishop of the Roman Catholic Church. Mariotte, a pure physicist, discovered the blind spot in the retina. Boyle anatomized, experimented on the circulation and respiration, started chemistry on new paths and perpetuated his name in attachment to an im-

portant physical law. Hooke, most versatile of all, claimed priority for a host of discoveries, and did in fact explore nearly every branch of science with brilliant, though often inconclusive results. Malpighi was an investigator equally great in vegetable and in animal anatomy and physiology, and what a glorious time it was for the microscopists, like Malpighi, Leeuwenhoek, Swammerdam and others, who could immortalize their names by turning the new instrument on a drop of muddy water, or blood, or other fluid, or a bit of animal and vegetable tissue! From the funeral sermon upon Nehemiah Grew, practitioner of physic and one of the founders of vegetable anatomy and physiology we are assured that he was "acquainted with the theories of the heavenly bodies, skilled in mechanicks and mathematicks, the proportions of lines and numbers, and the composition and mixture of bodies, particularly of the human body" and also "well acquainted with the whole body of Divinity and had studied Hebrew to more proficiency than most divines."

The early proceedings of the various scientific societies and academies, started in this century and destined to become powerful promoters of science, afford excellent illustrations of the wide scope of scientific inquiry. A quotation from the narrative of the famous mathematician, Dr. Wallis, gives further evidence of the position of the medical and other sciences in the aims and work of the little band of thoughtful students of nature who assembled in Oxford in 1645 and later in London, constituting the so-called invisible college, which grew into the Royal Society. He says:

> Our business was (precluding matters of theology and state affairs) to discourse and consider of philosophical enquiries and such as related thereto:—as Physick, Anatomy, Geometry, Astronomy, Navigation, Staticks, Magneticks, Chymicks, Mechanicks and Natural Experiments; with the state of these studies and their cultivation at home and abroad. We then discoursed of the circulation of the blood, the valves in the veins, the venæ lacteæ, the lymphatic vessels, the Copernican hypothesis, the satellites of Jupiter, the oval shape (as it then appeared) of Saturn, the spots on the sun and its turning on its own axis, the inequalities and selenography of the moon, the several phases of Venus and Mercury, the improvement of telescopes and grinding of lenses for that purpose, the weight of air, the possibility or impossibility of vacuities and nature's abhorrence thereof, the Torricellian experiment in quicksilver, the descent of heavy bodies and the degree of acceleration therein, with divers other things of like nature.

The work and publications of the small group of physicians and men of science composing the Accademia del Cimento, which was established in Florence in 1657 and flourished unfortunately for only ten years, exemplify in an equally striking manner the combination of medical with other scientific pursuits and the wide range of study.

Borelli, the most important member of this academy, founded the so-called iatro-physical school of medicine, which contested the field for supremacy with the iatro-chemical, to which I have already referred, during the greater part of the seventeenth century. The story of these two schools is epochal and occupies the larger part of the history of physic during this century. Medicine owes to adherents of each school a large debt for important contributions to knowledge and fresh directions of thought. Where physical methods and knowledge, as they then existed, were applicable, as in investigation of the circulation and of the action of muscles, the iatro-physicists carried off the palm, Borelli's "De motu animalium" being one of the medical classics. But notwithstanding the great inferiority of chemistry to physics at this time the paths of discovery opened, although not traveled far, by the iatro-chemists have led to more im-

portant results. The beginnings of our knowledge of digestion and of secretion and even of the chemistry of the blood and other fluids are to be traced in the main to the iatro-chemical school, and the study of fermentation, although this was not conceived in the same sense as to-day, of gases, salts, acids and alkalis was of importance to medicine as well as to chemistry.

There never has been a period in medical history, not even in recent years, when so determined an effort was made to convert medicine into applied physics and chemistry as that in the seventeenth century. Descartes's dualistic philosophy, which left no more room for the intervention of other than mechanical forces in the organized world than in the inorganic, had great influence upon the minds of physicians as well as of physicists. Galileo had founded, and a line of great experimental philosophers from him to Newton had vastly extended, the science of dynamics, which then seemed to many, as in potentiality it may be, as applicable to all the activities of living beings as to the inanimate universe. There came in the first quarter of the century the greatest physical discovery in the history of physiology, that of the circulation of the blood, which opened the large biological tract of hæmodynamics to rewarding study by the new physical methods. The balance, the pendulum-chronometer, the thermometer and other newly invented instruments of precision were turned to good account in anatomical, physiological and pathological investigations, and physicians began to count, to weigh, to measure, to calculate and to discover a world of form and structure hidden from their unaided vision. Such chemistry as existed was pursued almost exclusively by physicians and primarily in the interest of medicine.

What wonder, then, that physicians who came under the influences of this great awakening in physical science and took no small part in its advent and promotion, should have entertained hopes, soon doomed to disappointment, of the benefits to medicine from application of the new knowledge and have promulgated hypotheses and systems of doctrine which seem to us so false and extravagant! Great as was the advance in physical knowledge, it was utterly inadequate for many of the purposes to which the iatro-physicists and iatro-chemists applied it, and to this day many of their problems remain unsolved.

Grateful we should be for valuable discoveries and new points of view which medicine owes to these men, often so unjustly criticized, but the time had come for men of our profession to resume the Hippocratic method of collecting facts of observation within their own clinical field, and Sydenham, of all the physicians of his century the name, next to Harvey's, most honored by medical posterity, in calling out, "back to Hippocrates!" turned the face of medicine again toward nature.

There are interesting points of comparison between Sydenham's position in the history of medicine, and that of his fellow-countryman and contemporary, John Ray, in natural history. I am sorry that my profession, which has fostered so many ardent students of nature, including Linnæus and Agassiz, the respective bi-centenary and centenary anniversaries of whose birth have been celebrated with such enthusiasm in the year now closing, can not claim this greatest naturalist of his century. Both Sydenham and Ray stood apart from the great scientific movement of their day; both, little influenced by theory or tradition, concentrated their efforts strictly within their respective fields of observation, and both introduced new methods of studying their subjects. As Ray, the plants and animals, so Sydenham described diseases as objects of nature, his

discriminations and descriptions being in several instances the first, and to this day in some cases unsurpassed and unimpaired by new knowledge. Like Ray, he was not a mere species-monger, but he had the synthetic power to assign the proper place to single observations and to combine them into well-ordered groups. By way of contrast, the attempt of Linnæus to classify diseases into species and genera, although of some historical interest, was utterly barren, the subject-matter permitting no such method of approach as that which enabled this great systematist to start a new epoch in botany and zoology.

With the close of the seventeenth century we reach a dividing line, which limitations of time compel me to make on this occasion a terminal one, in the historical survey of the interrelations of medicine and the natural sciences. I can not, however, refrain from at least the bare mention of the influence of physicians on the development of science in America—a theme which I hope on some other occasion to take up more fully. Leonard Hoar, doctor of medicine of Cambridge, England, brought something of the new experimental philosophy to America, and during his short incumbency of the presidency of Harvard College (1672–1674) planted the first seeds of technical training on American soil, but too early for them to germinate. Of much greater importance was Cadwallader Colden, an Edinburgh doctor, acquainted with the Newtonian mathematics and physics, and a botanist of note in his day, who did much to instil an interest in physical and natural science among physicians and others in Philadelphia and New York in the first half of the eighteenth century. Besides John Bartram, who studied and to some extent practised physic, the founder on the banks of the Schuylkill of the first botanical garden in this country, there is a long line of American medical botanists, as Clayton, Colden, Mitchell, Garden, Kuhn, Wistar, Hosack, Barton, Baldwin, Bigelow, Torrey, the teacher and collaborator of Asa Gray, himself a graduate in medicine, Engelmann, whose names are perpetuated in genera of plants, and many others up to this day. Until the coming of Agassiz, who trained many who did not enter medicine (although among his pupils were also not a few medical men, including the Le Contes and A. S. Packard), most of the zoologists were also physicians, and Agassiz found already at work in his field in Boston the physicians, Gould, Storer, Harris, and one worthy of a place by his side, Jeffries Wyman. Of the delightful naturalist type of physician there have been many, such as Samuel Latham Mitchell, John D. Godman, Jared Kirtland, and above all a man who belongs to the world's history of biological and paleontological science, Joseph Leidy, whose monument was recently dedicated in Philadelphia. Geologists will call to mind such names as Gibbs, Newberry, John Lawrence Smith, also a chemist and mineralogist, and the Le Contes; and ethnologists the names of Samuel G. Morton, Daniel G. Brinton and Edward H. Davis. How many of the Arctic explorers from this country, as Kane, Parry, Hayes, Schwatka, as well as from England, have been physicians! There have been many whose interest in science was first awakened by the study of medicine, but who were not graduated as doctors, as Joseph Henry, Sears Cook Walker, Thomas Sterry Hunt and Spencer F. Baird. Particularly interesting as investigators in physical science were members of the medical families of the Drapers, the Le Contes and the Rogers. This bare mention of a few of the American medical contributors to science, mostly of an earlier period, will perhaps afford some indication of the services of medicine to scientific development in this country.

After the seventeenth century in Europe the natural sciences, though often cultivated by those educated in medicine and practising it, were independent and followed their own paths, which, however, communicated by many by-ways with the road of medicine and with each other.

Botany and zoology acquired their independent position probably more through the work of Ray and Willughby than by that of any other naturalist. Botany, however, remained for over a century still mainly in the hands of physicians. An interesting chapter in its history is the story of the various apothecaries' and other botanical gardens established through the efforts of physicians and conducted by them primarily for the study of the vegetable materia medica. From such beginnings has grown the Jardin des Plantes in Paris, started by two physicians, Herouard and la Brosse, in 1633, into the great museum of natural history made by Buffon, Cuvier and others as famous for the study of zoology as by Brongiart and his successors for botany. Less humble was the foundation of the British Museum and its appanage, the great Museum of Natural History in South Kensington, the gift to the nation of his valuable collections in natural history and other departments by Sir Hans Sloane, a leading London physician in the first half of the eighteenth century.

Boyle's name is associated especially with the foundation of chemistry as a separate science. William Cullen deserves to be remembered in the history of this science, who, although not an important contributor to chemistry as he was to medicine, was in the second half of the eighteenth century the first to raise the teaching and study of chemistry to their true dignity in the universities of Great Britain, and imparted the first stimulus to his pupil and successor in the Edinburgh chair of chemistry, William Black.

Mechanics, never really dependent upon medicine, was lifted by Newton to analytical heights, rarely scaled by disciples of Æsculapius, although, as Thomas Young and Helmholtz have exemplified, not wholly beyond their reach. But not all of physics stands on the lofty plane of abstract dynamics constructed by Newton, Lagrange, Laplace and Gauss, the highest probably hitherto attained by the human intellect. There have been many educated in medicine who have made notable contributions to the physics of sound, heat, light, magnetism, electricity and the general properties of matter and energy. I have collected, without any pretence to exhaustiveness, the names of over a hundred physicians or men trained for the practise of medicine or pharmacy who have made contributions to physics sufficiently notable to secure them a place in the history and records of this science. A few of the more important are Gilbert, van Musschenbroek, Sir William Watson, Black, Galvani, Berthollet, J. W. Ritter, Olbers, Wollaston, Thomas Young, Oersted, Dulong, Mayer, Thomas Andrews, Sainte-Clair Deville, the Drapers, Foucault, Helmholtz. Sir Humphry Davy literally sprang out of the lap of medicine into the Royal Institution, just founded by Count Rumford, who himself had begun the study of medicine before he left his native country. If the surgeons of England at that time had only heeded what Davy told them concerning the anesthetic properties of nitrous oxide gas, America would have been deprived of the greatest service which she has rendered to medicine.

In the long line of important physiologists of the past century who represent especially the physical direction of investigation in their important branch of medicine and biology, there are not a few whose names find a place in the histories of modern physics, as E. H. Weber, Du Bois Reymond, von Brücke, Ludwig, Fick, Vierordt,

Poiseuille and others, and the studies of the botanists, Pfeffer and de Vries, on the turgor of vegetable cells opened an important field of physical chemistry.

Aspects of my subject, full of interest, which I can now barely touch upon, are the influence of previous medical or biological training upon the work of a physicist or chemist, and closely connected with this the extent to which purely physical problems have been approached from the biological side. Call to mind how the central physical and chemical problem of the eighteenth century, the nature of combustion, was throughout this period intimately associated with the kindred physiological problem of respiration, and how John Mayow in the seventeenth century, approaching the subject from the biological side, reached a conclusion in accord with that fully demonstrated a century later by Lavoisier, who thereby opened a new era for physiology as well as for chemistry. For the first time clear light was shed upon the function of respiration, the nature of metabolism and the sources of animal heat, and such physical interest was attached to the study of these physiological phenomena that physicists of the rank of Laplace, in association with Lavoisier, Dulong, W. E. Weber, Magnus, A. C. Becquerel, Hirn, Regnault, and of course Helmholtz, have all made valuable contributions to the elucidation of these subjects.

The study of electricity, especially after the physiologist, Galvani's epochal discovery, more correctly interpreted by Volta, engaged the attention of physicians and physiologists scarcely less than that of physicists. The latter became greatly interested in animal electricity, a subject partly cleared up by the physicists, Ritter and Nobili, but mainly by the physiologist, Du Bois Reymond. Ostwald points out, as a matter of interest in the history of the human mind, that the physician Soemmering was led to conceive of the transmission of intelligence by electricity from analogy with the conveyance of impulses by the nerves, and thus to invent his practically useless form of the electric telegraph. However fanciful such a relationship may be, it is interesting, as Sir David Brewster discovered, that the first proposal for an electric telegraph worked by statical electricity was made and actually carried into effect as early as 1753 by the Greenock surgeon, Charles Morrison. It is now well understood that no one has the sole credit of inventing the electric telegraph, the idea of which was implicit in Stephen Gray's observation in 1727 of the transmission of electricity by a wire.

Of curious interest is the introduction of electricity for the treatment of disease by the physicists, Kratzenstein, Nollet and Jallabert, shortly before the middle of the eighteenth century, who reported cures by its use.

There is no more striking illustration of the correlation of two apparently distinct lines of approach to the same problem than the attack from the biological and from the purely physical sides upon the thermodynamic problem, which is as fundamental for biology as for physics. The conception of the principle of conservation of energy was supplied independently and almost simultaneously on the one hand by students of the conditions of mechanical work done by the animal machine and on the other hand by investigators of technical machines. Much of the essential preliminary study was on the biological side by Boyle, Mayow, Black and Lavoisier. Mainly from the same side the physician and physicist, Thomas Young, first formulated the modern scientific conception of energy as the power of a material system to do work. Davy and Rumford contributed, and from the physiological side Mohr, Mayer and Helmholtz, and from the purely

physical side, after preliminary work by Poncelet and Sadi-Carnot, Joule, Thomson and Clausius reached the same grand conception. The first to enunciate clearly and fully the doctrine of the conservation of energy and to measure the unit of mechanical work derived from heat was the physician, J. R. Mayer. Joule's work completed the demonstration, but Mayer's name is deservedly attached to this principle by Poincaré and others, as Lavoisier's is to that of the conservation of mass, and Sadi-Carnot's to the principle of degradation of energy. As regards this last principle it is almost as interesting to biologists as to physicists that in the so-called Brunonian movement, discovered by the physician and more eminent botanist, Robert Brown, and the subject of interesting physical investigations in recent years, we behold an apparent exception to the principle of degradation of energy, such as Clerk Maxwell pictured as possible to the operations of his sorting demon.

I must forego further citation of examples of this kind of correlation between the work of physicists and of physiologists, and leave untouched the chemical side, which is much richer in similar illustrations. The significance to organic chemistry of the synthesis of urea by Wöhler, and to agricultural chemistry of the bacteriological studies of nitrification in the soil and fixation of nitrogen in plants, will perhaps indicate how large and fascinating a field I must pass by.

The great advances in physics and chemistry initiated in France toward the end of the eighteenth and beginning of the nineteenth century were quickly reflected upon the medical and biological sciences through influences which in large part are attributable to this new movement in physical science. New methods of physical examination of the patient were introduced, and pathology and experimental and chemical physiology were developed as biological sciences of the first rank. This reformation of the medical sciences in the first third of the nineteenth century was mainly the work of Frenchmen, the great names in this development being those of Lavoisier, Bichat, Laennec and Magendie, the last a friend and physician of Laplace, and contemporary of Cuvier, who represented a like movement in zoology. Liebig, the pupil of Gay-Lussac and founder of biological chemistry as a distinct science, carried in the third decade of the century the new spirit to Germany, where Johannes Müller and his pupils became the center of a movement which rescued medicine and biology from the shackles of the philosophy of nature and has given Germany the supremacy in these fields of science. The experimental physiological work of the brothers Weber, two being physicians and the third the great physicist who was so intimately associated with Gauss in Göttingen, was of great influence in introducing the physical direction of physiological research, but Magendie stands first in making the experimental method the corner-stone of normal and pathological physiology and pharmacology.

Most pertinent to my theme is it to note that the light which has transformed the face of modern practical medicine came in the first instance not from a physician but from a physicist and chemist, Pasteur. The field of bacteriological study was placed on a firm foundation and thrown open to ready exploration by Robert Koch, and thereby that class of diseases most important to the human race, the infectious, became subject in ever-increasing measure to control by man. Thus hygiene and preventive medicine, through their power to check the incalculable waste of human life and health and activities, have come into relations, which have only begun to be appreciated, with educational, political,

economic and other social sciences and conditions, and with the administration of national, state and municipal governments. It is an especial gratification to record the stimulating recognition of these relationships by the social and economic section of this association in which was started a year and a half ago a movement for public health, particularly as related to the federal government, which has already assumed national significance.

To the marvelous growth of the medical and other sciences of living beings during the past century, and especially in the last fifty years, physics and chemistry and the application of physical and chemical methods of study have contributed directly and indirectly a very large and ever-increasing share. In many instances there is no telling when or where or how some discovery or new invention may prove applicable to medical science or art. Who could have dreamed in 1856 that Sir William Perkin's production of the first aniline dye should be an essential link in the development of modern bacteriology and therefore in the crusade against tuberculosis and other infectious diseases? As Robert Koch has said, it would have been quite impossible for him to have developed his methods and made his discoveries without the possession of elective dyes for staining bacteria, and no other class of coloring agents has been discovered which can serve as substitutes for the anilines in this regard. And how much assistance these dyes have rendered to the study of the structure and even the function of cells! If we trace to their source the discovery of Röntgen's rays, which have found their chief practical application in medicine and surgery, we shall find an illustration scarcely less striking.

No important generalization in physical science is without its influence, often most important, upon biological conceptions and knowledge. I have already referred to the great principles of conservation of mass and of energy which are at the very foundation of our understanding of vital phenomena. Although we can not now foresee their bearings, we may be sure that the new theories, regarding the constitution of what has hitherto been called matter, will, as they are further developed, prove of the highest significance to our conceptions of the organic as well as of the inorganic world. Clerk Maxwell in his article on the atom in the ninth edition of the Encyclopædia Britannica, on the basis of a computation of the number of molecules in the smallest organized particle visible under the microscope, reached a conclusion which he states in these words:

> Molecular science . . . forbids the physiologist from imagining that structural details of infinitely small dimensions can furnish an explanation of the infinite variety which exists in the properties and functions of the most minute organism.

Larmor, in the tenth edition of the same work in his article on the ether, points out that upon the assumption of either vortex atoms or electric atoms physical science is concerned only with the atmosphere of the atom, that is with the modification impressed on the surrounding ether, whereas the nucleus or core of the atom may perhaps be taken into account in the problems of biology, although it would appear that nothing can be known of this nucleus. With still later developments of the dynamical hypothesis, which resolves matter into nothing but activity or energy, there are those who think that the hard knot of ages is to be untied and the animate and inanimate worlds come together under a satisfying monistic view of the whole as in essence active energy.

The ultimate problems of biology reside in the cell. Whatever the future may hold in store, at the present day only a relatively small part of these problems are approachable by physical or chemical

methods, and the day is far distant, if it ever comes, when cellular physiology shall be nothing but applied physics and chemistry. We can not foresee a time when purely observational and descriptive biological studies, which to-day hold the first place, shall not continue to have their value. They represent the direction which makes the strongest appeal to the great majority of naturalists. The broadest generalizations hitherto attained in biology, the doctrine of the cell as the vital unit and the theory of organic evolution, have come from this biological, as distinguished from physical, direction of investigating living organisms, and were reached by men with the type of mind of the pure naturalist, who loves the study of forms, colors, habits, adaptations, inheritances of living beings.

It is well that the sciences of nature hold out attractions to so many different types of mind, for the edifice of science is built of material which must be drawn from many sources. A quarry opened in the interest of one enriches all of these sciences. The deeper we can lay the foundations and penetrate into the nature of things, the closer are the workers drawn together, the clearer becomes their community of purpose, and the more significant to the welfare of mankind the upbuilding of natural knowledge.

William H. Welch
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SCIENTIFIC BOOKS

Neure Anschauungen auf dem Gebiete der Anorganischen Chemie. By Adolph Werner. Braunschweig, Vieweg und Sohn. 1905. Pp. xii + 189. Price 6 marks.

The book before us presents a system for classifying inorganic compounds in such a way that "complex salts," "molecular compounds," hydrates, etc., as well as simple substances, may be included. The fundamental idea which underlies Werner's scheme is a new conception of valence. It is a well-established fact that in many cases compounds in which all of the valences of the individual atoms seem to be fully saturated, still possess the power of combining with other similarly saturated compounds to form complex salts. From this fact Werner draws the conclusion that we must drop our idea of independent, definitely directed valences. In place of this conception he introduces that of "affinity"—an attractive force acting, in the manner of an electrical charge on a sphere, from the center of the atom and uniformly distributed on its surface. Valence is then simply an empirical relation regarding the effect of this force on other atoms. Through considerations based on manifold experimental data he decides that this valence—the manifestation of "affinity"—must be of two kinds which he calls, respectively, *principal* and *subordinate* valence. The former produces the combinations of atoms met with in ordinary salts, giving rise to ionizable radicles; this property can be expressed in modern terms by saying that principal valences can bind atoms or molecules to electrons. Subordinate valences are also active in joining atoms to atoms, but in no case can they produce ionizable substances. Thus in the case of compounds between platinum, ammonia and chlorine we have the following series of compounds in which Cl outside of the brackets represents ionizable chlorine—primary valence—and that enclosed by the brackets non-ionizable chlorine—subordinate valence:

$$[Pt(NH_3)_6]Cl_4;\ \left[Pt{(NH_3)_5 \atop Cl}\right]Cl_3;\ \left[Pt{(NH_3)_4 \atop Cl_2}\right]Cl_2;\ \left[Pt{(NH_3)_3 \atop Cl_3}\right]Cl;\ \left[Pt{(NH_3)_2 \atop Cl_4}\right].$$

It will be seen that the total number of molecules bound directly to platinum is a constant —six—called by Werner the "coordination" number. He has found that for all of the elements forming "complex salts" this "coordination number" is either four or six.

That there is ground for Werner's dissatisfaction with the present conception of valence, no one can doubt, especially after reading the introductory chapters of this book. It is equally clear that in his new classification

Werner has given a sufficiently elastic idea of the action of atoms upon one another to account for many of the facts which at present are anomalies. The chapters on isomerism and steroisomerism too are suggestive and a number of interesting new relations have been presented. It is unfortunate, however, that the direct evidence for his theory is given in this book in so unsatisfactory a manner. His use of physico-chemical arguments is frequently very careless, his proofs for the constitution of compounds are often unconvincing, and the great mass of material is presented in no very clear and orderly fashion. The result is that the reader, if not previously acquainted with Werner's ideas and work, finds that the book leaves merely a confused impression. For a clear, brief presentation of the subject the reviewer recommends the reading of a lecture delivered by Werner before the *Deutsche chemische Gesellschaft* (Ber., **40**, 15). The book will then be valuable as an amplification of his paper.

HERMAN SCHLESINGER
UNIVERSITY OF CHICAGO

A Manual of Biological Projection and Anesthesia of Animals. By AARON HODGMAN COLE, A.M., Instructor in Biology and Projection in the Chicago Normal School. Chicago, Neeves Stationery Company. Pp. 200. $1.50.

The author of this little volume is to be congratulated on having produced a very useful and timely manual on the technique of projection. The scope of the work will be seen from the following partial table of contents: outline of methods and comments of educators on results obtained; available lights and their limitations; solar projection apparatus and its management, methods of darkening rooms, different types of screens; artificial lights and their management; methods of anesthetizing typical animals and plants; how to collect a large variety of species of animals and plants suitable for micro-projection and keep them alive in aquaria; directions for making different types of glass cells in which live animals and plants are mounted for projection; the knack of mounting and projecting various microscopical preparations, including live plants and animals; the projection of pictures and other opaque objects by the use of reflected light.

From the viewpoint of composition, with the possible exception of a few involved and somewhat obscure sentences, the book is clearly written and the subject-matter well arranged, although, in a few instances, there is a tendency toward what appears to be unnecessary repetition. However, the author doubtless feels—and justly so—that this may be forgiven in the interest of clearness. There seems to be no possible contingency in method or material that the author has not anticipated and given explicit directions for obviating, from which it is evident that the book is the outcome on his part of years of practical experience in projection work. The "ready reference table" (p. 180) for mounting and projecting a large number of objects, ranging from bacteria to living chick embryos, should prove of great convenience to the manipulator. The text is farther elucidated by the aid of twenty-eight figures and diagrammatic sketches.

In the words of the author, "every method described is the outgrowth of a need felt in teaching in some grade in grammar and high school, college and popular educational work, and each one has been tested in practise." This statement in itself is indicative of the wide range of uses to which the projection microscope may be put to-day.

M. F. GUYER

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES

THE New York Academy of Sciences held its annual meeting on Monday evening, December 16, at the Hotel Endicott, about seventy members and their friends being in attendance.

The report of the corresponding secretary showed that during the last year the academy had lost, by death, one honorary member, Professor Asaph Hall, and three corresponding members, Professor George Chapman Caldwell, Professor W. H. Chandler and Dr. Charles B. Warring. The names of two

honorary members and twelve corresponding members have been removed from the rolls through failure to reply to communications for five years or more. At the meeting three honorary members were elected, viz.: Dr. James Ward, professor of mental philosophy in the University of Cambridge, England; Professor J. D. Hooker, late director of the Royal Botanical Gardens, Kew, England, and Professor William Bateson, professor of zoology in the University of Cambridge, England. There are now forty-nine honorary members and one hundred and forty-six corresponding members upon the rolls.

The recording secretary reported that there were now five hundred active members of the academy, nineteen of whom were associate active members. Of the active members one hundred and twenty-two are fellows.

The chief features in the history of the academy during the past fiscal year were the exhibition of the progress of science which was held at the American Museum of Natural History, December 28 and 29, 1906, and the celebration of the two hundredth anniversary of the birth of the naturalist Linnæus on May 23, 1907.

After the reading of the reports was finished the academy elected the following list of fellows from among the active members: William Campbell, A. H. Elliott, L. P. Gratacap, Robert T. Hill, Isaac Adler, Emerson McMillin, Herman Knapp, John B. Smith, Ernest E. Smith and Horace White.

The treasurer's report showed that the financial condition of the society was flourishing. One feature of the report upon which emphasis should be laid is the fact that the academy has in its keeping two important funds, the income of which is available for the encouragement of scientific research. These are the Esther Herrman Building Fund and the John Strong Newberry Fund. Grants from the income of these funds are made to members of the academy or of the affiliated societies upon application and endorsement by the society of which the applicant is a member.

The librarian's report showed a large increase in the library and an enhancement of value through the filling of some important vacancies in our sets of books. Members and the public in general should bear in mind that the library, which is cared for by the American Museum of Natural History, may be freely used any week day between the hours of nine and five, and that such users are very welcome.

According to the editor's report, part 3 of Volume XVII. of the *Annals* is nearly ready for distribution, and the printing of Volume XVIII. has been begun.

The annual election resulted in the choice of the following officers for the year 1908:

President—Charles F. Cox.

Vice-Presidents—A. W. Grabau, Frank M. Chapman, D. W. Hering, Adolf Meyer.

Recording Secretary—Edmund Otis Hovey.

Corresponding Secretary—Henry E. Crampton.

Treasurer—Emerson McMillin.

Librarian—Ralph W. Tower.

Editor—Edmund Otis Hovey.

Councilors (three years)—Charles Lane Poor, William J. Gies.

Finance Committee—Charles F. Cox, George F. Kunz, Frederic S. Lee.

After the business meeting the members of the academy and their friends sat down together at dinner, at the conclusion of which the retiring president, Professor Nathaniel L. Britton gave an address upon "The New York Botanical Garden: Its Organization and Construction" which was illustrated with stereopticon views.

E. O. Hovey,
Recording Secretary

THE NEW YORK ACADEMY OF SCIENCES. SECTION OF BIOLOGY

The section met on December 9, 1907, at the American Museum of Natural History. The following program was presented:

The Effect of Centrifuging the Eggs of the Mollusc Cumingia: Professor T. H. Morgan.

Experiments were carried out in order to discover whether the cleavage pattern in a type with "determinate cleavage" is governed by the distribution of the visible substances of the egg, and also to discover whether the formation of the embryo is possible when the visible inclusions ("organ forming sub-

stances") of the protoplasm are artificially shifted.

The eggs of *Cumingia* when laid contain the first polar spindle in the center of the egg. The centrifugal force drives the scattered yolk granules to one pole, the pinkish pigment to the opposite pole. Between these two there remains the perfectly clear kinetoplasm, in which the spindle lies, forming any angle with the induced stratification. Its original position has, in fact, been little affected by the movement of the other substances through the egg, although its polar rays may suffer to some extent by prolonged centrifuging. Under the pink cap and concealed by it in the living egg is a vesicular material that is the nuclear sap of the ovarian egg. The polar bodies may appear at any point of the surface of the egg, so far as the location of the three zones is concerned. It is probable that the spindle comes to the same pole as in the normal egg. Since the eggs are not oriented as they fall any one of the three kinds of materials may lie at the "animal pole."

The cleavage always begins beneath the polar bodies, as in the normal egg, and the cleavage pattern, the size of the cells, and their tempo of division are exactly that of the normal. All of the yolk, for example, may be contained in the small cell of the first two, yet the size of this cell and its rate of division are not thereby affected.

It follows that in this egg *the determinate type of cleavage is not caused by the distribution of the visible substances of the egg.* Sections show that between the time of centrifuging and the appearance of the cleavage planes the induced distribution is to a large extent retained, the amount of disturbance depending on the length of time elapsing and on the location of the polar spindle, etc. The results confirm observations on the living egg, and show that the yolk or the pigment may go largely or entirely to one of the first formed cells.

The centrifuged eggs produce swimming embryos, and in some cultures a large percentage of such embryos. Until isolation experiments have been successfully carried out it is necessary to speak with some reserve concerning the percentage of normal embryos.

In the sea urchin egg Lyon has shown that the cleavage follows the induced stratification while in *Cumingia* this is not the case. The difference is due to the shifting of the nucleus in the egg of the sea urchin, while the spindle in *Cumingia* retains its original orientation.

The Replacement of an Eye by an Antenna in an Insect: DR. RAYMOND C. OSBURN.

The specimen in question is a male of *Syrphus arcuatus* Fallén (Diptera), a common and widely distributed species, and was collected at Montreal, Canada, by Mr. G. Chagnon who noted nothing unusual in its behavior. The right side of the head is normal, but on the left side the large compound eye is entirely wanting. A third antenna appears on this side of the head posterior to the normal left antenna and entirely separated from it, occupying a fossa of its own. It is normal in structure except that the arista, or dorsal bristle, is undeveloped, and it is slightly smaller than the normal ones. This condition calls to mind Herbst's experiments in Crustacea (*Palæmon, Sicyonia*) where an antenna developed in regeneration after the excision of the eye, but no similar case is known among insects as far as the writer is aware. It is possible that the eye may have been suppressed owing to some accident during metamorphosis and that the antenna was produced in place of it. A second vertical triangle also appears in this specimen alongside of the normal one. This supernumerary triangle is similar to the normal in pilosity and in the arrangement of the ocelli, but the anterior median ocellus has no cornea and is represented merely by a small prominence.

A fuller description with figures will appear elsewhere.

Lantern slides were also exhibited showing views of a two-headed turtle with many abnormalities in the carapace and plastron.

A Naturalist in British East Africa: MR. HERBERT LANG.

The Tjäder Expedition to British East Africa was undertaken for the purpose of collecting material representing the fauna of that region. From Mombasa, the expedition

(which consisted of Mr. Richard Tjäder and Mr. Lang, accompanied by 100 negro porters) proceeded 327 miles inland by the Uganda Railroad to Nairobi. A strip of territory one mile on either side of the railroad is set aside as a government game preserve, and is a place of refuge for mixed herds of antelopes, zebras and ostriches.

After spending a month collecting with great success on the Athi Plains, the expedition moved northwest into the Rift Valley, encamping at Kijabe and at various points in the lake country.

Thence the course was southeast over the Laikipia Plateau to Mount Kenia (18,000 feet), which the party ascended to a height of 14,000 feet. Lack of provisions, however, compelled a return to the railroad, whence the party proceeded to the coast, stopping to collect at intervals.

Four and a half months' collecting netted the expedition a total of about 500 skins of birds and mammals. The most noteworthy of the latter was the skin and skeleton of a fine bull elephant carrying 160 pounds of ivory, 4 rhinoceroses, 1 buffalo, 2 giraffes, one of which is unusually large, 8 zebras representing different districts, and a fine series of antelopes. Lions, spotted hyenas, aard-wolves and other carnivores were also taken. Mr. Lang also secured a remarkable series of photographs illustrating the flora, fauna and ethnology of the region. The talk was well illustrated with colored lantern views.

Roy Waldo Miner,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 194th meeting of the society on October 30, 1907, Mr. F. E. Wright exhibited a model for use in the study of crystal optics and also described a new method for measuring extinction angles of minerals in the thin section.

Regular Program

A Visit to the Alps: Mr. Bailey Willis.

Mr. Willis gave an account of a trip in the Alps during August and September. He stated that he had investigated the geological structure of the northern or front Alps and of a part of the Bernese Oberland with reference to the character of the great overthrust faults. He outlined his results in a broad way, but reserved more definite discussion for future presentation to the society. An especially pleasing feature of the trip was the cordial and generous assistance rendered by Swiss geologists.

A Comparison of some Paleozoic and Pre-Cambrian Sections in Arizona: Mr. F. L. Ransome.

The Paleozoic rocks of the Grand Canyon of the Colorado south of the Kaibab Plateau rest with conspicuous unconformity upon the Algonkian sediments and upon the basal crystalline rocks. Between the Algonkian sediments (Unkar and Chuar terranes) and the crystalline rocks is another great unconformity. Considerable confusion has arisen in the literature of the pre-Unkar crystalline rocks which Walcott called the Vishnu series and described as metamorphosed sediments. These crystallines, from the point where they emerge from beneath the Unkar south of Vishnu's Temple to the foot of the Bright Angel trail and west of that point, are dark, fine-grained gneisses cut by red granite and are probably all Archean. There appears to be no ground for describing the Vishnu as "bedding quartzite" or as metamorphosed sediments, and the vertical bedding referred to by Powell and Walcott is gneissic banding or foliation.

On the basis of Powell's and Walcott's characterization of the "Grand Canyon schists," or Vishnu, as metamorphosed slates and quartzites, certain crystalline schists in the Bradshaw Mountains, and in the Globe, Clifton and Bisbee districts, which are clearly metamorphosed sediments, and which are unconformably beneath the Cambrian (Tonto), have been tentatively correlated with the Vishnu. There is, however, little real warrant for this correlation if the Vishnu is not an altered sedimentary series. It is suggested that the Pinal schist of Globe, Clifton and Bisbee and the Yavapai schist of the Bradshaw Mountains may be equivalent in age to the Unkar and Chuar groups in the Grand Canyon. In that case, the great unconformity found at the

base of the Paleozoic rocks in the Range Region of Arizona is the pre-Tonto, and not the pre-Unkar, unconformity of the Grand Canyon.

The Tonto sandstone (Cambrian) of the Grand Canyon is probably the equivalent of the Apache group in the Globe District, of the Colorado quartzite in the Clifton District, and, without much question, of the Bolsa quartzite of the Bisbee District. The Tonto shale of the Grand Canyon section apparently becomes more calcareous to the south and is correlated with the Abrigo limestone of Bisbee. Both carry middle Cambrian faunas, according to Mr. Walcott. Neither Ordovician nor Silurian is known in the Grand Canyon, nor at Globe nor Bisbee. Mr. Lindgren, however, has found Ordovician at Clifton and some beds of this period may possibly occur in the lower part of the Globe limestone, which is chiefly Devonian and Pennsylvanian. The persistence of the comparatively thin Devonian from the northern to the southern boundary of Arizona is rather remarkable in view of the fact that in the Grand Canyon the Devonian Temple Butte limestone is seldom over 100 feet thick, is lacking in some places and is bounded above and below by unconformities. At Bisbee, the Devonian Martin limestone is about 350 feet thick. The Mississippian and Pennsylvanian limestones are both strongly developed at the Grand Canyon and at Bisbee, but the Pennsylvanian has not been found at Clifton. At Globe only Pennsylvanian fossils have been found but between the Devonian and Pennsylvanian horizons are a few hundred feet of apparently conformable limestones which may in future yield Mississippian fossils.

FRED E. WRIGHT,
Secretary

DISCUSSION AND CORRESPONDENCE

A BETTER METHOD OF PREPARING HERBARIUM SPECIMENS

MODERN critical study and exacting taxonomic methods require to-day more abundant and better-prepared herbarium specimens. These must be made by specialists for specialists. The private herbarium can no longer be maintained, and the training we give students must be such as will fit them to do the work the well-organized educational or research institutions demand.

Mere illustrative material in elementary botany beginners should collect in great abundance—the profit of their course of instruction depending largely on their assiduity manifest in getting and studying judiciously selected specimens, including, of course, careful observation of the environment and the conditions under which the plants occur. This work, in fact, serves well as a preparation or training for collecting and preparing good herbarium specimens. The better knowledge one possesses the better collector he may be. Supposing, however, that the collecting has been properly done and the specimens ready to go in press, we will now concern ourselves with the modus operandi of drying.

The old method of using "dryers" to take up the moisture, substituting dry sheets of the absorbent paper for the moist ones after ten to twenty-four hours, repeating the operation continuously for at least the larger part of a week, is unsatisfactory for two distinct reasons. First, too much labor is required and too much time is consumed; second, many of the specimens do not become dry quickly enough and therefore lose the fresh life-like appearance and natural color which quick drying generally secures. A better method will reduce the labor, shorten the time, and almost or quite invariably ensure better results.

Such a method is dependent on an altogether different principle, namely, removing the moisture by a current of dry warm air instead of absorbing it by bibulous paper and then promptly removing the latter. It is extremely easy of execution. The ordinary slat press may be used—the sides, however, may be plane boards, or stiff cloth-board, if that is preferred. The pressure is secured by straps or cords in the usual way.

In place of the "dryers," or rather alternating with these, *corrugated straw boards* are used. The rolls of such paper, usually found

in the wholesale paper stores, have corrugations on one side only. After being cut the usual size, twelve by eighteen inches, they should be glued two and two, so that each piece would then present corrugations on both exposed sides—the corrugations running crosswise, not lengthwise.

To fill the press, proceed as follows: Place on the work-table one side of the press, and on it lay a sheet of thick soft paper, or the ordinary "dryer" sheet may be used. On this put the thin species-sheet, on or in which the prepared specimen has been placed; then cover with a corrugated board. On the latter a specimen would be laid as in the beginning, again add a soft sheet or "dryer"; finally another corrugated board; and so on until all the specimens have been inserted.

If the pile is six to eight inches high, or even higher, all the better. After strapping the press properly, suspend it over the stove or other form of heater. The rising warm air will pass freely by the corrugations and quickly carry the moisture from the specimens.

The next day remove the specimens, when ready to put in others freshly collected. If leaves or stems are succulent, or if there are berries or other fruits containing very much moisture, five or six hours' drying will scarcely suffice, as it will in case of ordinary specimens; in that event, they would be allowed to remain in the press longer.

In a few stubborn cases it is not possible to arrange twigs, leaves or flowers to best advantage until they have lost some of their moisture. It would be well to place such occasional specimens in the old-fashioned press, or between "dryers" under some pressure for a short time, possibly over night; and then transfer them to the warm-air press to be quickly completed for the herbarium.

It is desirable to have the rope, which is used to suspend the press over the heater, follow the upper edge but *pass under the two straps* or cords that secure the press and furnish the pressure on the specimens; the weight of the packet itself will then continue the necessary pressure—which otherwise the shrinkage by loss of moisture would tend to lessen. If the press is set on the hot register or radiator, or on an iron support over a heater, it will be desirable to have a short spring inserted in each of the straps, so that the slack will be promptly and effectually taken up as the drying proceeds.

If a small oil stove or a lantern is used to induce the current of warm air—usually the case when one is off on an extended expedition—it is quite necessary to have the press three feet or more above the heater. Then a piece of canvas or thick muslin, a yard wide, must be drawn around the press closely, hanging down so as to form a chute or sleeve to properly direct the warmed air.

The "soft" sheet separating the two specimens that are between each two corrugated boards, might be the ordinary "dryers" used in the old-style press, as signified above, provided, however, that they are not hard or firm. It is very desirable to have something *easily indented* by thick parts, otherwise they will injuriously press into the corrugated boards. The Riker Company, that first made this kind of press furnished a layer of cotton batting for the *soft* intermediate sheet; but it does not prove satisfactory on continued use. Somewhat similar material, perhaps that which is delicately faced, "dress wadding," might be entirely satisfactory. I confess that I myself have not yet passed the experimental stage touching this part of the work.

The suggestion that specimens dried so quickly and thoroughly would be exceedingly brittle does not seem to have proved true; but even if that should be the case, the specimens are much improved in this respect by following Dr. Millspaugh's method of poisoning, namely, by using some glycerine in the corrosive-sublimate solution. After use in the tropics in making an enormous number of herbarium specimens, I can say that the principle embodied in this plant-press seems to be abundantly sanctioned by experience. Not only that, but it is possible to quadruple or quintuple the work accomplished. Besides, mouldy specimens—even when made in rainy seasons or in the moist tropical countries—are wholly unknown to this new press.

W. A. Kellerman

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SPECIAL ARTICLES

ALTAMAHA FORMATION OF THE COASTAL PLAIN OF GEORGIA[1]

THE name, Altamaha, was applied by Dr. W. H. Dall[2] in 1892 to a sandstone and gritty clay formation prominently exposed along the Altamaha and Ocmulgee Rivers of Georgia. The study of the formation was confined mainly to the above-mentioned rivers. Mr. R. M. Harper[3] later studied the formation in some detail from a phytogeographical standpoint. The age of the Altamaha and its relation to other formations of the coastal plain, however, have been unsettled. The writer has spent considerable time during the past summer in studying and mapping the formation and presents some conclusions concerning it.

The Altamaha is the most widespread formation of the coastal plain of Georgia, covering approximately 21,000 square miles or three fifths of the entire coastal plain of Georgia. Occurrences have been noted to within a few miles of the Atlantic coast. Good exposures of red sand and clay are found near Savannah, Waynesville, Brunswick and Kingsland, while the probabilities are that it occurs on the sea islands. It thence extends northward into Burke County to within twenty miles of Augusta on the Fall Line. Thence going in a southwestward course its northward extent is marked by the towns of Tennille, Dublin, Hawkinsville and Vienna to Flint River. West of Flint River no formation has been identified with certainty as the Altamaha, except in Decatur County, in the extreme southwestern part of the state. Southward it extends into Florida.

As a whole the Altamaha consists of yellow and red sand and both massive and stratified layers of gritty clay, with local areas of indurated grit or sandstone and clay. The surface aspect, which is peculiarly characteristic throughout the terrane, is a mottled or "calico" effect; that is, the weathered surface is a splotched red, yellow and white and very frequently purplish and white, due to unequal weathering and oxidation of iron minerals. At some localities small brown iron oxide accretions from the size of buckshot to walnuts are abundant at the surface, and the land where these are found is commonly referred to as "pimple" land. These iron oxide pebbles are products of weathering of the Altamaha clay-sand and are almost certain evidence, where found, that the underlying formation is the Altamaha. The topography of the Altamaha formation is rolling and unlike that of any other coastal-plain formation.

The sand of the formation is usually a coarse quartz sand, red and yellow or orange in color, and occasionally has a brownish tint. It is always more or less argillaceous and contains, frequently, layers of small quartz pebbles. A characteristic of these pebbles is their angularity, some being lath-shaped, showing scarcely any rounding of the angles. The pebbly feature is nowhere very prominent and is exceptional rather than general. In a few localities, the pebbles are rather large, attaining a diameter of four or five inches. Near the Atlantic coast and in the southwestern part of the state the sand may be fine grained, rarely micaceous, crossbedded, and interstratified with thin layers and leaves of plastic clays. These clay layers may not exceed an inch in thickness. Such structure is seen in the exposures of the Altamaha near Jesup and Waynesville in Wayne County and near Whigham in Grady County.

The clay of the Altamaha is fairly uniform in texture and composition throughout the Altamaha area. It is a greenish or drab, very fine-grained and highly plastic and always more or less sandy. It has a low specific gravity and absorbs a high percentage of water. It often has an acid or sour taste, due, likely, to aluminum sulphates. It occurs in thick irregular pockets or thin lenticular layers or leaves, never persisting as in individual beds over any large area. A tolerably characteristic appearance throughout is greenish clay, full of coarse angular quartz particles and subangular decomposed feldspar pebbles. The clays may be locally indurated, the ce-

[1] Published by permission of the state geologist of Georgia.

[2] Bull. No. 84 U. S. G. S.

[3] *Annals N. Y. Acad. Sci.*, Vol. XVII., Pt. I.

menting material being opaline silica. As above mentioned, the clays are generally green and drab, but in the vicinity of Thomasville there are white clays containing as little as two per cent. of iron oxide.

The grit or sandstone feature of the Altamaha, the feature which is most striking and which was first studied, is typically exposed along the Altamaha River. It consists of gray or greenish aluminous sandstone more or less mottled and stained by iron oxide. In restricted localities pebbles are imbedded in the sand and clay matrix, and cemented into a conglomerate; but, except for the pebbles, these beds do not appear different from the typical Altamaha sandstone. The percentage of clay in the indurated rock varies from five to ten per cent. to such a high percentage that the rock is an indurated clay rather than a sandstone. The cementing material is an opaline silica and the rock may be extremely hard and even glassy and quartzitic in appearance, but is generally, however, soft and friable. The rock is strikingly similar in its lithological aspect throughout widely separated areas and is easily identified, although it is entirely devoid of any fossils. Except along the Altamaha River, only widely separated outcrops occur. It never presents any great thickness, jutting beds fifteen or twenty feet thick being exposed over a few acres. Exposures of grit are common throughout the northern part of the Altamaha region, but are not observed near the coast nor the Florida boundary line. It is believed that these isolated exposures are local indurations only and not parts of a continuous sandstone bed.

While in the foregoing the sand, clay and sandstone are described separately, they do not form stratigraphical units. Sand, clay and sandstone may be seen in the same vertical section, in which the clay may be replaced by sand, and sand and gritty clay may be seen gradually changed from non-indurated to indurated rock, from soft sand and clay to typical Altamaha grit.

The thickness of the formation can be ascertained only from data from deep well borings. The Altamaha in Georgia attains a known thickness of 350 feet and probably reaches 500 feet. From this maximum thickness, which occurs in the counties of Emanuel, Tatnall, Toombs, Coffee and Tift, it is attenuated both northward and southward. The thickness in the southwest part of the state can hardly be more than 200 feet as a maximum, and on the Atlantic coast probably does not exceed 100 feet. As a whole, the study shows evidence of a rapid deposition in a shallow basin-like sea. There is a notable absence of any calcareous layers or nodules, chemical analyses, even of both the clays and the sandstone, showing only a trace of lime or none at all. The material composing the Altamaha was largely derived from the metamorphic and igneous rocks of the Piedmont region.

The Altamaha has been observed overlapping and overlying Eocene, Lower Oligocene, Upper Oligocene, Miocene and questionably Pliocene strata and is to some extent a superficial deposit.

In Burke and Washington counties, in the northeast part of the coastal plain, the Altamaha is observed overlapping red sand and gravel belonging to the Claiborne (Eocene) group. The red sand of the Claiborne contains thin quartzitic layers with Eocene fossils, and can hardly be mistaken for the Altamaha, although the two may in places have similar texture and color.

It overlaps Lower Oligocene rocks (Vicksburg group) in the counties of Pulaski, Dooly and along the east side of Flint River down to Camilla. Near the contact with the Vicksburg group it is frequently found to contain flint fragments, which are evidently derived from the Vicksburg.

At a number of points in Decatur, Grady and Thomas counties, the Altamaha overlies beds of Upper Oligocene age, seemingly without unconformity. On the Monticello road, four miles southwest of Boston, red and brown sands of the Altamaha pass by a gradual transition into clay and sand containing fragments of oysters and the coral, *siderastrea,* which identify the beds as Upper Oligocene. This might be taken as evidence of identity

of beds, but more probably the deposition of the Altamaha resulted in the intermixing of beds of similar material, thus obliterating any sharp line of contact between the two, and the apparent continuity of deposition may be thus accounted for. Likewise, at Attapulgus, in Decatur County, red sands and green clay overlie without noticeable unconformity a fuller's-earth deposit, which is regarded as being the equivalent[4] of the Alum Bluff beds.

An excellent vertical section, showing the relation of the Altamaha to Miocene strata, is exposed in the bluff of the Altamaha River at Doctortown, where thirty feet of stratified Altamaha clay and sand overlie a fossiliferous bed containing Miocene pectens. The fossiliferous bed here is four feet thick and is composed of bluish-gray sand full of large pectens and a calcareous sandy layer one foot thick, full of small bivalves and comminuted shells. The section of the bluff is:

	Feet
1. Yellow and mottled argillaceous sand	10
2. White and yellow cross bedded sand containing thin layers of small pebbles	10
3. Red and yellow stratified sand, containing thin clay laminæ or leaves	10
4. Calcareous fossil sand	1
5. Bluish sand, containing pectens	3
6. Bluish sand clay	7

No. 1 of this section has the typical mottling of the Altamaha sand and brown iron oxide accretions are found at the surface as elsewhere over the Altamaha region. The above section is of considerable interest because of the light that it throws on the age of the upper thirty feet of strata. The bluff is referred to by Dall[5] as being Altamaha grit and is described by McGee[6] as Lafayette. A section identical with the one given above occurs at Linders Bluff, three miles above Doctortown, and similar sections are found in the bluffs of the Altamaha River several miles below Doctortown—the upper and lower Sancivilla bluffs. No fossils, however, were observed at the Sancivilla bluffs, except bits of lignitized plant remains.

[4] T. W. Vaughan, Bull. No. 213, p. 392.

[5] Bull. No. 84, U. S. G. S.

[6] U. S. G. S., 12th Ann., Pt. I., p. 484.

The Altamaha has not been identified with certainty lying in contact with strata bearing Pliocene fauna, but there is strong probability that it does overlie such strata. A marl bed overlain by clayey sand outcrops on the Satilla River six miles below Atkinson, from which fossils were collected by Mr. S. W. McCallie and identified by Mr. T. H. Aldrich, as being Pliocene. The Altamaha is exposed at Waynesville, a few miles east of Atkinson, and undoubtedly overlies the above-mentioned marl beds on the Satilla River. Also, marine shells and vertebrate remains brought up by recent dredgings at Brunswick further suggest the probability of Pliocene fossil beds near the coast.

Overlying the Altamaha formation unconformably there is everywhere a thin mantle or superficial layer of loose sand of Pleistocene age. This sand is a light gray or brown in color, shows no stratification, is free from clay, and is always easily distinguished from the Altamaha. It varies in thickness from 0 to 50 or 60 feet, and the average thickness is not more than 10 feet. This sand presents a remarkable uniformity in color and texture throughout the whole coastal plain, from the sand hills of the fall line to the Atlantic coast.

Summing up the known facts concerning the Altamaha formation, the writer is inclined to regard it as being late Pliocene in age. The formation itself contains no fossil evidence which will aid in determining its position, being devoid of all fossil remains except a few bits of wood; and the conclusion concerning its age is reached from the knowledge that it overlies Miocene and Pliocene strata and is older than the coastal Columbia sand, which is of Pleistocene age. The correlation of the numerous exposures of the Altamaha has been determined by stratigraphical continuity, homogeneity and physiographic features. Beginning with an outcrop of typical Altamaha in the northern part of the Altamaha region, it was traced by examination of exposures at short intervals to the Atlantic coast and to Florida. In Georgia, at least, it is believed that it is identical with the formation which McGee considered Lafayette. In his study of the Lafayette in Georgia, in the Twelfth An-

nual Report of the U. S. Geological Survey, references are made to Millen, Green's Cut, Waycross and Doctortown as being localities where the Lafayette might be seen. The beds at the localities mentioned can undoubtedly be correlated with the Altamaha.

Otto Veatch
Geological Survey of Georgia

CURRENT NOTES ON METEOROLOGY AND CLIMATOLOGY

LIGHTNING VAGARIES

In the *Quarterly Journal of the Royal Meteorological Society* for October, 1907, there is an account, given by Professor A. Herschel, of a remarkable excavation made by lightning in peat earth in a moorland district of Northumberland. A large hole, four or five feet in diameter, was found on a flat part of the moor, radiating from which there were six or seven furrows, and pieces of turf were thrown in various directions. The largest turf, about three feet in diameter and one foot thick, was lying 26 yards away, and other pieces were lying around within 20 yards of the hole. On excavating the hole it was found that a number of small holes radiated to various depths. Col. J. E. Capper gives an account of a captive balloon being struck by lightning.

CLOUD CLASSIFICATION

Professor Willis I. Milham, of Williams College, has published a useful pamphlet on *Cloud Classification,* intended for the use of his students in meteorology, as a guide in their practical work on cloud classification and origin (8vo, pp. 9). This pamphlet considers very briefly (1) the early history, (2) the international system, (3) the causes of clouds and (4) the thirteen cloud forms. The discrepancy between the usual ten forms of the International Classification and the thirteen here referred to comes from the fact that Professor Milham counts fracto-stratus, fracto-cumulus and fracto-nimbus each as one form. Together with the description of the individual types, reference is made to the methods of formation.

METEOROLOGICAL FORMULÆ AND TABLES

Professor Paul Schreiber, director of the Meteorological Service of Saxony, publishes a series of "Formeln und Tabellen" as a *Vorarbeit* to his Annual Report for 1903 (Dresden, 1907, fol.). These formulæ and tables deal chiefly with the thermodynamics of the atmosphere, and are designed for practical use in meteorology. The formulæ are given at the beginning. A discussion on their use follows, and a series of diagrams at the end illustrates the various physical conditions and processes concerned.

A "STEP" ANEMOMETER

At a recent meeting of the Royal Meteorological Society (*Quart. Journ. Roy. Met. Soc.,* October, 1907) Mr. Walter Child exhibited and described his "step" anemometer, which he has designed to obviate the "sheltering error." This instrument is a Robinson anemometer, with the cups so placed on the spindle that the arms are in different horizontal planes. Thus one cup does not shelter another, and the system comes to rest more rapidly when the wind drops.

R. DeC. Ward

THE MEETING OF THE INTERNATIONAL SEISMOLOGICAL ASSOCIATION

The first general assembly of the International Seismological Association since its formal inauguration in 1905, and the second meeting of its permanent commission, were held at the Hague from September 21–26, last.

Twenty-two states are now members of the association, England, Austria and Canada having joined since last year. Although France has not formally joined, preliminary steps have been taken for this purpose and it is hoped that she will soon be a regular member. Chile, the Congo, Norway, Portugal and Roumania are the only countries, members of the association, which were not represented at the meeting. There were about fifty persons present either as delegates or as invited guests, and this included a majority of the leading seismologists of the world. Professor van der Stok and his assistants made all the arrange-

ments for the meeting most successfully. We were given free use of the excellent social club at the Hague: the Minister of Colonies gave a dinner and a reception, and an excursion was made by boat through the canals; altogether the visit to the Hague was extremely agreeable and its memory will always be a pleasure.

According to the by-laws only the delegates are admitted to the meetings of the permanent commission, but this rule has never been enforced, so that all persons attending the general assembly also attended the meeting of the permanent commission. The general assembly has not a permanent president, but the chair is occupied in rotation by different members. The permanent commission elects its president for four years. Signor Palazzo, of Italy, was the retiring president; and Professor A. Schuster, of Manchester, England, was elected president for the next four years. Professor Forel, of Switzerland, was elected vice-president for two years; and the next meeting of the permanent commission was fixed to take place in Switzerland two years hence; Strassburg was continued as the central bureau of the association for the next four years.

The report of the central bureau showed that it had made careful studies of seismological instruments at Strassburg during the last year and that it had published the catalogue of earthquakes for the year 1904. This list is arranged chronologically, but it was suggested that future lists, which are to be made by the central bureau, should have a different arrangement, namely, that the earthquakes should be grouped regionally. The details of the publication of the new catalogues were put in the hands of a sub-committee. The central bureau has also published all the seismograms of the Valparaiso earthquake, or at least all of which it could obtain the originals. These have been reproduced by a heliograph process so as to be exact, and comprise 140 plates, 32 by 42 cm. each. This will furnish an opportunity for a careful comparison of the seismograms of one great world-shaking earthquake.

At the Rome meeting of the permanent commission in October, 1906, a prize was offered for the best cheap seismograph, the details of the competition being left to the central bureau. The conditions imposed were that the instruments should not cost more than about 300 Marks, that it should record one component of the movement and should magnify from 40 to 50 times. The results were not very satisfactory. The low limit of the price seems to have kept out some competitors, so that only four competing instruments were exhibited at the Hague. One of these, shown by Professor Agamennone, consisted of two horizontal pendulums at right angles to each other and supported by pivots; between them was a horizontal pendulum arranged to record the vertical motion. All three instruments recorded on smoked paper and on a single drum. The price of this instrument was 550 Marks; but in view of the fact that all three components were registered, it was admitted to the competition. Spindler and Hoyer, mechanics of Göttingen, exhibited an inverted pendulum of the Wiechert type weighing about 80 kilograms, which recorded the two horizontal components on a single drum, and magnified from 40 to 120 times. The price of the instrument was 350 Marks. The same mechanics also exhibited a pendulum for vertical movement which had a gridiron arrangement to prevent shifting of the instrument by changes of temperature. This instrument cost 550 Marks and was accordingly excluded. The third instrument, made by Schmidt, of Utrecht, Holland, was a small inverted pendulum recording the two horizontal components on a single drum; the whole instrument did not occupy more space than about one cubic foot and its magnifying power was about 200. These instruments are to be sent to Strassburg and their relative efficiency carefully tested before the prize is awarded.

It has been the tendency of the association to refer all investigations to the central bureau. There was a reaction against this at the Hague meeting, and the new investigations ordered were put into the hands of special

committees. For instance, a special committee was appointed to consider the form of the next catalogue of earthquakes; another to consider the question of seismological bibliography; a third will collect information regarding mistpoeffers, and a fourth will study microseismic movements; the latter are continued movements of periods usually between four and eight seconds, which sometimes last for hours and even days. They have been observed throughout the world and have been supposed to be due to variations of the barometer, to winds, to the beating of the waves upon the shore, etc.

There were a number of scientific papers presented. Professor Wiechert gave his conclusions regarding the interior of the earth as the result of seismological observations. He finds that the velocity of the first preliminary tremors of an earthquake is about 7.2 kilometers per second at the surface of the earth and increases gradually to a depth of 1,500 kilometers; there it suddenly increases to 12.8 kilometers per second. Below that depth the variations are slow for some distance but finally approach the velocity of 10 kilometers near the center. Professor Wiechert considers that this confirms his earlier idea of a central core of iron or steel surrounded by a stony layer, and that it fixes the radius of the core at 4,500 kilometers, and the thickness of the stony layer at 1,500 kilometers. The existence of long vibrations of periods of 18 seconds or more reveals, he thinks, the existence of a layer of liquid or plastic material at a depth of about 30 kilometers from the surface.

Prince Galitzin advocated the use of strong electro-magnetic damping and electro-magnetic recording for seismographs. He showed a small horizontal pendulum provided with coils of wires in a strong magnetic field. One set of coils served to damp the instrument and the second set was connected with a dead beat galvanometer whose deflections are recorded photographically. The velocity and not the displacement of the pendulum is recorded. Although requiring considerable skill for its installation, this instrument promises to be very valuable.

Professor Rosenthal gave the results of his studies of seismograms. He thinks that the periods of vibrations, during the principal part of the movement, increase progressively and therefore concludes that the seismogram is drawn out for somewhat the same reason that the spectrum is. It is to be noted, however, that other observers have failed to detect the progressive change of period.

Harry Fielding Reid

SCIENTIFIC NOTES AND NEWS

A "Life of Lord Kelvin" is in course of preparation by Professor Sylvanus P. Thompson. It will be published by The Macmillan Company.

At the Chicago meeting of the American Society of Naturalists, Professor D. P. Penhallow, of McGill University, was elected president, and Professor H. E. McKnower, of the Johns Hopkins University, secretary.

The president of the American Chemical Society, Professor Marston T. Bogert, of Columbia University, has been reelected for the ensuing year.

Professor George E. Stratton, of the Johns Hopkins University, has been elected president, and Professor A. H. Pierce, of Smith College, has been elected secretary, of the American Psychological Association.

Professor Hugo Münsterberg, of Harvard University, has been elected president, and Professor W. P. Montague, of Columbia University, vice-president, of the American Philosophical Association.

The Chicago Section of the American Mathematical Society, meeting in affiliation with the American Association, elected Professor G. A. Miller chairman, and reelected Professor H. E. Slaught secretary, for the ensuing year.

Dr. Walter M. Mitchell has been appointed director of the Haverford College Observatory.

Dr. Theobald Smith, professor of comparative pathology at Harvard University, has received the degree of doctor of laws from the University of Chicago.

DR. NICHOLAS SENN, whose lamented death occurred while the American Association for the Advancement of Science was meeting in Chicago, had just received the Order of Merit of the Japanese Society of the Red Cross by the sanction of the Emperor of Japan. Dr. Senn had likewise been elected an honorary member of the Royal Medical Society of Budapest.

PRESIDENT ARTHUR T. HADLEY, of Yale University, will complete his course of lectures in the Roosevelt professorship, established by Columbia University at the University of Berlin, in about five weeks and, with his family, will sail for this country, arriving in New Haven about March 1.

SIR THOMAS CLIFFORD ALLBUTT, M.D., regius professor of physic, at Cambridge, was entertained on December 16 at a complimentary dinner by the Master of Downing and the medical men of Cambridge, in the hall of Downing College, upon the occasion of his being created a Knight Commander of the Bath.

COUNT MAURICE DE PÉRIGNY gave a lecture before the Geographical Society of Pennsylvania on January 8, entitled "Some Unknown Ruins in Yukatan."

THE Society of Biblical Literature and Exegesis at a meeting held at the University of Pennsylvania on December 31, passed the following resolution:

WHEREAS, Charges reflecting on American Oriental scholarship have been publicly made against Professor H. V. Hilprecht.

Resolved, That this society shares in the desire already expressed by a number of American Oriental scholars that a complete reply to these charges be made in the journal of the society or elsewhere.

A MEMORIAL to Herman Brehmer, the inaugurator of sanatorium treatment of tuberculosis, is to be unveiled at Breslau, at the time of the twenty-ninth Balneological Congress, which convenes on March 5.

ACCORDING to foreign journals, the Russian Physico-chemical Society has arranged to hold a conference of general and applied chemistry in honor of Mendeléeff in the course of the present month at the University of St. Petersburg. Several discourses will be delivered on the great chemist's life and works. A subscription has been started for the purchase of a Mendeléeff House, which, like the Hofmann House in Berlin, would be used for the meetings of learned societies.

DR. CHARLES AUGUSTUS YOUNG, the eminent astronomer, died at Hanover, N. H., on January 4.

DR. NICHOLAS SENN, the distinguished surgeon of Chicago, professor in the Rush Medical College, died on January 2, at the age of 63 years.

PETER TOWNSEND AUSTIN, Ph.B. (Columbia '72), Ph.D. (Zurich '76), at one time professor in Rutgers College and the Brooklyn Polytechnic Institute, and since 1896 practising as a chemical expert, died on December 30, aged fifty-five years.

PIERRE CHARLES CESAR JANSSEN, director of the Meudon Astrophysical Observatory, died on December 23, at the age of eighty-three years.

THE Association of American Universities has been meeting at the University of Michigan, Ann Arbor, this week.

THE American Breeders' Association will hold its fourth annual meeting at Washington, D. C., January 28–30, 1908, in the National Rifles Armory and Carroll Hall. The program includes reports on scientific investigations in heredity and also addresses and discussions by practical men on the improvement of animals and plants. The scientific, economic and human aspects of heredity will also be substantially presented in the reports of over forty permanent committees of the association.

THE Oklahoma University Science Club was organized in October last, to meet twice a month. Membership is limited to regular faculty instructors in the various science departments and includes at present seventeen individuals. The officers are: *President,* Edwin DeBarr, professor of chemistry; *Vice-president,* Cyril M. Jansky, professor of physics; *Secretary-treasurer,* Henry H. Lane, professor of zoology and embryology; *Chairman*

of the Executive Committee, Albert H. Van Vleet, professor of botany. The object of the club is "to promote original research" among its members. The following papers have already been read:

"The Snakes of Oklahoma," by Professor Van Vleet.

"Modern Methods in the Extraction of Ores," by Professor De Barr.

"Recent Advances in Serum-therapy," by Professor Williams.

"Some Observations n the Cuban Cave Fishes," Professor Lane.

The department of anthropology of the University of California has come into possession of the linguistic and ethnological manuscripts of the late P. S. Sparkman, of Valley Center, California, comprising the results of his many years' studies of the Luiseño Indians.

A restoration of the skull of a great horned dinosaur has just been installed for exhibition in Peabody Museum, Yale University. It is nearly nine feet long, and about six feet broad, and is said to be the largest skull of any prehistoric land animal.

Austrian papers announce the formation, by the joint action of the Academies of Sciences in Vienna, Prague and Krakow, of an Austrian Egyptological institute at Cairo. The yearly expenses are estimated at 30,000 to 40,000 crowns. The first excavations are to be made at Fayûm.

In order to observe the eclipse of the sun on January 3, which appeared as a total eclipse in the tropical Pacific Ocean, Mr. C. G. Abbot, director of the Astrophysical Observatory of the Smithsonian Institution, has been sent to Flint Island, 400 miles northwest of Tahiti. The eclipse was total between eleven and twelve o'clock in that longitude, which corresponds to between four and five o'clock Washington time. Mr. Abbot, with an assistant, joined a party headed by Professor W. W. Campbell, of Lick Observatory, California, sailing on the steamship *Mariposa* from San Francisco to Papeete, Tahiti, on November 22. The gunboat *Annapolis* furnished transportation between Tahiti and Flint Island. Mr. Abbot's observations comprise an examination with the Langley bolometer of the sun's corona, especially toward its inner part, to help decide what is the most probable cause of its luminosity. For this coronal light three sources have been suggested: (1) the reflection of ordinary sunlight, (2) the emission of light owing to the high temperature of small particles near the sun, and (3) the emission of light by luminescence like that of the aurora borealis. It was proposed also to observe with instruments the peculiarities of sky light before the day of the eclipse so that even if clouds should obscure the eclipse, there would still be something of value brought back from the trip.

According to the London *Times* Dr. Sven Hedin, writing from Gargunsa, under date of November 8, states that he has been down to Nepal from Tradum, crossing the Pass of Kore-la. The explorer afterwards crossed for the fifth time the mountain range, about 2,000 miles long, from the Salwin to the Panj, collecting valuable details. Dr. Sven Hedin has discovered the true source of the Brahmaputra River—namely, the Kubitsampo, which rises from a glacier on the northern side of the northernmost parallel range of the Himalayas. The Marium-chu, which has hitherto been regarded as the source, is merely a small tributary flowing in from the west. After a careful study of the hydrographic problems regarding the Manasarowar and the Sutlej, Dr. Sven Hedin proceeded round the Troly Kailas, discovered the true source of the Indus, and traveled northeast to the thirty-second degree of latitude north. He is now proceeding to Ladakh and Khotan *via* the road running east of the Karakoram Pass. In the spring he will travel either to Peking or India.

There was a meeting at the Carnegie Institute, Pittsburg, on January 2, of those interested in medical education, at which the following questions were discussed:

First—Realizing that four years in college and four years in a medical school are too much of a man's life to ask in preparation for his profession, the Academy of Medicine proposes to so arrange the college courses and the medical courses that six years only will be required.

Second—"State medical examination laws."

Each state requires a state medical examination before a doctor can practise within its borders. The academy proposes that a uniform examination be held in every state and that a doctor who has passed this examination in one state may be admitted to practise in any other state without again taking an examination.

DAMAGES to the amount of $456,746.23 were awarded the New Liverpool Salt Company on December 31, by Judge Olin Wellborn, in the United States District Court, against the California Development Company on account of the destruction of its property in the Salton Sea caused by the overflow of the Colorado River. The overflow resulted, it was alleged, from the construction of canal intakes by the development company.

IN the material received from the Belgian government for the Congo exhibition, at the American Museum of Natural History, are extensive assortments of native mats, baskets, iron implements and musical instruments. Among the musical instruments are an unusually long ivory trumpet and a drum five feet in length. Other articles of interest are those which constitute a Congo sorcerer's outfit, consisting of a face mask, a dog-tooth necklace and several fetishes in the form of human figurines rudely carved in wood. The museum has secured from Professor Eugene Schroeder a collection of ethnological material from the Bismarck Archipelago in the South Pacific Ocean. Among the objects in the collection are several Malagans, or idols, from a Tabu, or Ghost house; an example of the ancient Death Drum, which was sounded only on the demise of a chief, and several masks which were used by the men in the Init dance. The remainder of the collection consists of implements of war and the chase, musical instruments, personal ornaments, clothing and household utensils.

THE *Nation,* which now has a department devoted to science, says: "Professor Charles Moureu of the École Supérieure de Pharmacie has studied various springs at the spot where the water gushes from the ground. He finds that they give out continuous emanations of radium and comparatively large quantities of such rare gases as argon, neon and helium. The single spring of the Lymbe at Bourbon-Lancy yields annually more than 10,000 litres of helium. The Académie de Médecine commissioned three young physicians, having proper scientific attainments, to study certain well-known springs. M. Ameuilles found Plombières and Bad Gastein in Austria the most active, with an emanation which has all the properties of radium emanation. The sediment is also radio-active, and the surrounding atmosphere lightly so. An observation, which explains why it is not the same thing to use bottled waters and 'take the waters' at the springs, shows that this radioactivity disappears in a short time; within four days half of it was lost in water taken away from the spring. It is even probable that all spring water, taken at its source, is slightly radio-active."

THE London *Times* states that the Indian Humanitarian Committee recently called the attention of Mr. Morley to the strong feeling which exists among Indian people against the multiplication of Pasteur institutes and the spread of "preventive inoculation" under the patronage of the government of India, and expressed the hope that steps would be taken to lessen the large sum of animal suffering which is inflicted in physiological laboratories. The secretary has received the following reply from Mr. Morley's private secretary, saying that the secretary of state has "recently been in communication with the government of India regarding the restrictions enforced in that country on experiments on living animals, and that the principles of the English act (which have been generally observed in practise), will be formally applied to all laboratories and institutes. When the Royal Commission has reported, the subject will be further considered in the light of its recommendations."

THE coal fields of thirteen states and territories were examined by geologists of the United States Geological Survey in 1906, and the results of this work have been published by the survey as Bulletin No. 316. The importance of the coal industry at the present time is well illustrated by a comparison of the

values of the leading mineral products of the United States for the year 1906:

Coal	$513,079,809
Iron	505,700,000
Copper	177,595,888
Clay products	161,032,722
Oil and gas	137,318,667
Gold and silver	132,630,200

So far as fuels are concerned the work of the Geological Survey is divided into three classes, geologic, technologic and statistical, the last of which is in charge of the Division of Mineral Resources, whose work for 1906 yielded the figures given above. All the geologic work on mineral fuels of the United States is under the general supervision of Mr. M. R. Campbell. The work is of various grades and degrees of precision, depending on the needs of the public and the conditions under which the surveys are carried on. In the region west of the one hundredth meridian the coal fields are comparatively unknown and the work of the survey is largely exploratory. Rapid reconnaissance surveys are made over large areas to determine the limits of the field and to obtain such information regarding the number and character of the coal beds and their attitude as may be possible in the present undeveloped condition of the field and with the hasty method of examination. In the eastern fields information is needed almost as badly as in the west, but the work is of a much more detailed character and involves not only a thorough study of the geologic conditions under which the coal occurs, but also a study of the quality of the coal and its adaptability to various commercial uses.

Messrs. Sotheby, Wilkinson and Hodge have, as we learn from the London *Times*, concluded a two-days' sale of books and manuscripts, chiefly scientific, and including the technical library of the late Dr. M. T. Masters, F.R.S., for over forty years editor of the *Gardener's Chronicle*, and other properties. A total of £1,677 7s. was realized. The sale included: L. and H. G. Reichenbach, "Icones Floræ Germanicæ et Helveticæ," 1834–60, Vols. 1 to 19, with fine colored plates—£54 10s. (Wheldon); T. C. Jerdon, "The Birds of India," 1862, the author's own copy prepared for a new edition, with the collection of drawings made by the author to illustrate his book and also the original MS.—£250 (Grote); an extensive collection of about 1,000 English and foreign pamphlets, chiefly botanical, formed by Dr. Masters and bound in 131 volumes—£38 (Wheldon); C. Loddiges, *The Botanical Cabinet*, 1818–33, 20 volumes, with 2,000 colored plates—£27 10s. (Quaritch); and two works by J. Gould, "Monograph of the Trochilidæ, or Family of Humming Birds," with the supplement, 1861–87—£35 10s. (Quaritch); and "The Birds of New Guinea," 1875–88—£39 (Parsons).

UNIVERSITY AND EDUCATIONAL NEWS

Mr. John D. Rockefeller has added $2,191,000 to his previous gifts to the University of Chicago, making the total amount of these nearly $24,000,000. Of Mr. Rockefeller's recent gift, the sum of two million dollars is for permanent endowment; the sum of $155,000 is to meet the deficit for 1907, and the sum of $36,000 is for miscellaneous purposes.

Colorado College has completed an addition of $500,000 to its productive funds, towards which the General Education Board and Mr. Andrew Carnegie each contributed $50,000. The town of Colorado Springs raised $50,000 toward the fund in two weeks.

Miss Katherine Greenhill has bequeathed to Trinity College, Oxford, about $3,000 to found an exhibition for a medical student in memory of her father, the late William Alexander Greenhill, M.D., of Oxford.

The French government will build a college for women at St. Germain-en-Laye.

Miss Laura D. Gill has resigned the deanship of Barnard College, Columbia University. Dr. William T. Brewster, professor of English, is acting dean.

Dr. Edwin G. Conklin, since 1896 professor of zoology in the University of Pennsylvania, has accepted the chair of biology in Princeton University. It is understood that Princeton University has offered Professor Conklin unusual facilities for his research work as well as a larger salary than is received by any professor at the University of Pennsylvania.